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THE ATLANTIC TRANSPORT CO. is having built by the Maryland Steel Co., at Sparrow's Point, Md., two of the largest steel passenger and freight steam ships ever constructed in this country. These vessels are to duplicate the "Minneapolis" and "Minnehaha" of the same line. The general dimensions are: Length over all, 630 ft.; length between perpendiculars, 600 ft.; beam, 65 ft.; depth of hold, 44 ft. They will register 13,240 tons gross and carry 18,000 tons dead weight. These vessels will have twin-screws and a speed of 17 knots, loaded. The Maryland Steel Co. is also building two steel cargo carriers for the Boston Steamship Co., besides three torpedo-boat destroyers and the steel floating dry-dock for the government, to be stationed at Algiers, La. The Atlantic Transport Co. now has 17 vessels plying between New York, Philadelphia, Baltimore and European ports, and has also awarded a contract to the Harlan & Wolf Co., of Belfast, Ireland, for two more ships of the same dimensions as those now building at Sparrow's Point.

THE HAWAIIAN STEAMSHIP CO. is having a fleet of seven vessels built for its Pacific trade; and one of these, the "Hawaiian," was launched at the Roach shipyard, at Chester, Pa., on Nov. 7. This ship is 435 ft. long, 51 ft. beam and 23 ft. deep to water-bottom. The gross tonnage is 6,000 tons, and she is fitted with triple-expansion engines of 2,500 I. HP. Of the fleet of seven, the Roach yard will build three, two will be built at the Camden yard of the New York Shipbuilding Co., and two at San Francisco, Cal.

THE U. S. MISSISSIPPI RIVER DREDGE "BETA," says the Memphis "Scimitar," is to be sent down to the South Pass, about the first of next year, and put to work at deepening the channel there. This will require the lengthening of her suction tubes so as to excavate to a depth of 30 ft. Her floating discharge pipes, now 1,000 ft. long, will also have to be lengthened. This work is now being done, opposite Memphis, at a cost of about $20,000, according to the paper quoted.

THE AMERICAN STEAMSHIP CO., operating a fleet of ore-carriers on the Great Lakes, has been purchased by the American Steel & Wire Co. The latter company guarantees the prinicipal and interest of an issue of $5,250,000 5% bonds paid over to the stockholders for an interest that cost them originally $3,000,000. The vessels purchased cost $3,350,000 two years ago.

THE U. S. MONITOR "ARKANSAS" was launched at Newport News on Nov. 10. This is the first of the three new monitor-vessels, to be used as harbor defenders. She has a single balanced turret on the center-line forward, protected by 9 ins. of steel and intended to carry two of the new 12-in. rifles in addition to four 4-in. rapid-fire guns and three 6 pdrs. and four 1-pdr. guns arranged on the upper deck.

U. S. NAVAL ESTIMATES for the fiscal year ending June 30, 1902, aggregate $82,172,630; while the estimate for the previous year was $65,130,916. This increase is chiefly due to the necessity of continuing work on projects already authorized and started, as the new items in the estimates only aggregate $9,241,837. The largest single item is $6,693,260 for improvements at nearly all the navy yards and stations; $856,400 is for improvements at naval magazines and places under the Bureau of Ordnance; the "Increase of the Navy" calls for $21,772,917 for construction and machinery; $4,000,000 is for armor and guns, and $400,000 is for equipment. These estimates do not include vessels which Congress will be asked to authorize. For the pay of the navy $15,125,684 is required, based upon the assumption that Congress will authorize an increase in the personnel, as asked for. The Bureau of Equipment wants $4,464,802; the Bureau of Supplies and Accounts wants $4,883,849; the Bureau of Construction, $8,070,824, and the Bureau of Steam Engineering, $3,772,900. For new buildings at Annapolis an estimate of $3,000,000 is submitted.

THE ARMOR-PLATE CONTROVERSY, between the Government and the makers, is said to be adjusted. The terms are not made public, but it is reported that the Carnegie and Bethlehem companies have reduced the price of best Krupp hardened armor to $475 per ton, on condition that these two companies do all the work. The armor contracts will probably amount to about $19,000,000, as 14 armor-clads are affected.

A TENDER OF THE CHICAGO DRAINAGE CANAL to the U. S. Government has been put under way through the agency of the Deep Water Ways Commission. The action is taken under the following clause of the act creating the Chicago Sanitary District:

> When such channel shall be completed and the water turned therein, to the amount of 300,000 cu. ft. of water per minute, the same is hereby declared a navigable stream, and whenever the general Government shall improve the Desplaines and Illinois Rivers for navigation, to connect with this channel, said general Government shall have full control over the same for navigation purposes, but not to interfere with its control for sanitary or drainage purposes.

THE MARITIME CANAL CO.'S RAILWAY, extending from Greytown, Nicaragua, ten miles along the proposed route of the canal, has been reported upon by engineers sent out by the Government of Nicaragua. These engineers report the roadbed, cross-ties, etc., in good condition, and recommend that the line be extended 18 miles, to Sarapiqui, at deep water on the San Juan River. This extension, it is said, would reduce the time of transportation of goods between Greytown and Grenada from 4 to 5 days, to 24 hours.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Southern Ry., near Knoxville, Tenn., Nov. 9. A fast passenger and a double-header freight collided, killing one of the enginemen, seriously injuring four others and completely demolishing the three engines.

THE SIDE-WHEEL STEAMER "City of Monticello" foundered off Yarmouth Light in the Bay of Fundy on Nov. 10, and of the 37 persons on board only four were saved. A terrific gale was blowing at the time. The "City of Monticello" belonged to the Yarmouth Steamship Co. and had been engaged in the traffic from St. John, N. B., to Halifax by way of Yarmouth. She was a side-wheel iron boat of about 1,000 tons and was built at Wilmington, Del., in 1866.

A NEW NICARAGUAN RAILWAY LINE is proposed by the government, to connect the existing separate Grenada-Managua and Lake Managua-Corinto lines; thus avoiding the present costly transfer by steamer across Lake Managua. The connection would be about 37 miles long. U. S. Consul Sorsby, of San Juan del Norte, also says that the government has temporarily abandoned the construction of the proposed railway from San Ubaldo, on Lake Nicaragua, to Rama, near Bluefields. The government has lately given a concession to a Mr. Freeman, of New York, to build a railway from the Wawa River, on the Atlantic coast, to Matagalpa; and to connect at La Paz, or some other convenient point on the Pacific coast, with the Grenada-Corinto railway system. Under the terms of the concession the contractor must deposit $50,000 gold within six months of September, 1900; must commence work within one year and finish the entire line in four years, and must also improve the harbor in Wawa River, and establish a wharf and run steamers on the coast with New Orleans connections. The government is to guarantee 6% interest on $10,000 gold bonds per mile for 25 years; grant 4 sq. miles of land in alternate lots along the route, and the privilege to select at will and purchase 100,000 "manzanas" of land at prevailing government prices. This line would be about 250 miles long, and pass through mining districts and the coffee region of Matagalpa.

THE SPECIAL FIRE PROTECTION WATER MAINS at Philadelphia, which have been under discussion for some time past, may be authorized soon, the water committee of councils having approved plans for the proposed work. The system would include a 16-in. main on Delaware Ave. and Market St., a 12-in. main on Broad St. to and around the city hall and a number of 8-in. branches. For the present, the mains would be filled by pumps on the city fire boats, but eventually a pumping station would be erected. The water would be taken from the Delaware River. Mr. Wm. C. Haddock is director of the department of public works of Philadelphia, and Mr. Geo. S. Webster, M. Am. Soc. C. E., is chief engineer of the bureau of surveys.

THE LONDON METROPOLITAN DISTRICT UNDERground Railway invites bids and plans from the electrical engineers of the world for converting its road from steam to electric power. This means relaying and re-equipping about 50 miles of track, and the contract is to be awarded on Dec. 1. Bids are now coming in from England, Europe and the United States.

THE CUBA CO., lately organized at Philadelphia, with a capital of $20,000,000, has sent Sir William Van Horne, and his son, Mr. R. B. Van Horne, to Cuba, with the published intention of making an effort to secure options on all the horse and trolley railway lines in Cuba, including lines on sugar plantations. Among others present at the meeting of Nov. 8, where this action was taken, were William L. Elkins and Thomas Dolan, of Philadelphia, and R. A. C. Smith, President of the Cuba Mail Steamship Co.

A LEASE OF RUSSIAN GOLD-WORKINGS is to take place on Jan. 15-28, 1900, at the Ministry of Agriculture in St. Petersburg, according to information sent this journal by M. Routkowsky, Financial Agent of Russia, at Washington, D. C. The Mining Department of the Ministry of Agriculture and State Domains issues the following notice: It will sell at public auction a lease to private individuals of the working of the auriferous deposits on the northwestern shore of the Sea of Okhotsk. These deposits are on land drained by six rivers and bids are to be made for each river separately, for a term of 15 years. The preference will be given for the highest payment per "pud" of gold extracted, in addition to a duty of 1½% of the total product charged in kind. Each bidder must prove his responsibility and deposit 30,000 rubles; and if the bidder decline to sign his contract the deposit becomes the property of the crown. The successful bidder receives the exclusive right to mine, to use timber, and reindeer forage and pasturage. A brief account of the results of prospecting in this region and the full directions for bidding can be obtained by addressing the above.

A NEW STEEL PLANT is to be erected at Monterey, Mexico, by the Compania Fundidora Fierro y Acero. The plant will consist of a blast furnace of 400 tons daily capacity, for which the Wm. B. Pollock Co., of Youngstown, O., have the contract; five open-hearth furnaces, a foundry, rolling mill and structural works.

A PIG-IRON CASTING MACHINE has been installed by Hartman & Co., of Philadelphia, at a blast furnace in the Lehigh Valley district in Pennsylvania. The machine has a series of molds secured to a rotating table, which are brought successively under the pouring spout. The pigs are cooled by immersion in water and are transferred to a chain conveyor, which delivers them onto a railway car. The molds are coated with bituminous coal dust to prevent the molten iron from sticking to them.

THE PARIS EXPOSITION was officially closed on Nov. 12, and the work of removing the exhibits is to begin at once. Official statistics show that the Exposition was a success and 50,000,000 of people visited it, as compared with 25,121,975 in 1889. The maximum for one day's attendance was 600,000, as against 335,377 in 1889.

A ROAD-MATERIAL TESTING LABORATORY has been established in the Divisions of Chemistry of the U. S. Department of Agriculture. Arrangements are made to test physically and chemically all road materials, including rocks, gravel, shells, brick, clays, and all other bodies used for road building in country districts. Materials for street pavements in municipalities are not included. This laboratory will be in operation by Dec. 1, and instructions will be forwarded on application, touching methods of selecting and shipping samples. Address Mr. Martin Dodge, Director, Office of Public Road Inquiries, Department of Agriculture, Washington, D. C.

SEDIMENTATION TANKS WITH NUMEROUS CIRCULAR OVERFLOW WEIRS; DENVER UNION WATER CO.

Unique settling tanks have been in use on the works of the Denver Union Water Co., of Denver, for several years. The tanks are small and shallow, as compared with the general practice. In place of the ordinary weirs for drawing off the clarified water a multitude of small circular weirs is provided. A general view of the tanks in service is shown by Fig. 1, while Fig. 2 shows one pair of the tanks in plan and section, and Fig. 3

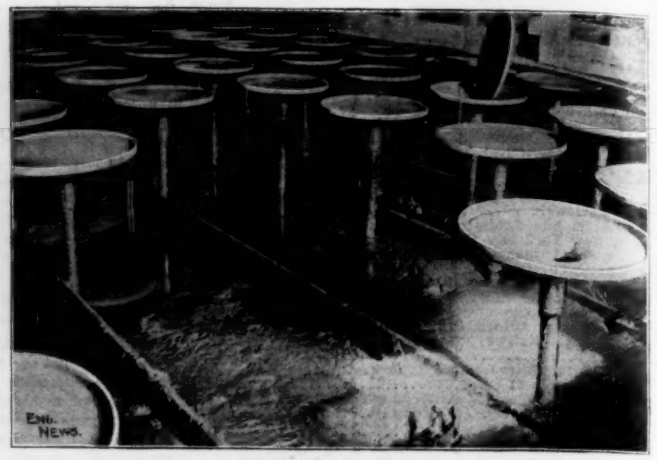


FIG. 1.—GENERAL VIEW OF SETTLING TANKS, DENVER UNION WATER CO. C. P. Allen, Chief Engineer.

FIG. 3.—DETAILED VIEW OF ONE OF THE SETTLING TANKS, WITH WATER DRAWN OUT.

is a second view, showing the weirs tank partitions and sediment retained in one of the tanks. We are indebted to Mr. C. P. Allen, Chief Engineer of the Denver Union Water Co., for the illustrations, and for the other material used in the preparation of this article. The tanks are described by Mr. Allen as follows:

The settlers are located near Platte Canyon, about 17 miles from Denver. The Platte River at certain seasons carries a large amount of silt, the deposit amounting to from 10 to 100 cu. ft. per 1,000,000 gallons of water. To remove this there was devised and constructed 16 wooden tanks, 20 × 20 ft. × 3½ ft. deep.

The tanks were located in pairs, about 4 ft. apart, the space between the double rows being utilized as a flume or conduit to supply the raw or unsettled water to the tanks. The amount of flow from the supply flume into each tank is controlled by a series of square iron gates. The washing out gates for removing the sediment are located opposite the inlets. The clarified water is drawn off through 90 1-in. pipes, set vertically and distributed evenly in the tank, all sedimented water passing over thin knife edge weirs 16 ins. in diameter. The inside of the weirs have an increasing slope, toward the center, with a corresponding increase in the velocity of the flowing water. This carries down large quantities of air through the 1-in. pipe, compressing the air and again liberating it below the bottom of the tanks. This method thoroughly aerates the water before it is delivered to the filters.

The water is caught on a second sloping bottom and conveyed to the collecting flume. A 12-in. pipe for each set of tanks carries the water to the filters. The partitions shown in Figs. 2 and 3 are for the purpose of controlling the flow of water through the tanks at different points for removing the sediment; this is accomplished by drawing water from the tanks and flushing each compartment separately. The sediment is carried away to low lands a short distance from the plant. Washing requires about thirty minutes to each tank with the labor of one man. This time varies according to the amount of sediment.

The partitions are each 14 ins. in height. Fig. 3 shows the depth of silt with the water drawn out and ready for washing.

When settlers were first constructed they were operated only during the summer months for two years, but they have proven so efficient that the company covered them in, since which date they have been operated continuously.

At the request of Mr. Allen, Prof. E. G. Smith, of Beloit, Wis., sent us the following information as to the results obtained by the use of the settling tanks:

On looking over the data I have for the past few years, I find that there is constant improvement of the water from the bacteriological standpoint in passing the settlers; they take out the mud and sediment in the water quite efficiently and in the process the organisms are carried down also. The water is brought to a rest and the sedimentation is considerable. A few chemical analyses have been made of the raw waters and the waters after sedimentation and the results are favorable. The waters from the Platte Canyon are peculiar and very variable in character, so that the treatment of them must be changed often within short periods. The system of sedimentation as used at this plant shows a distinct improvement of the quality of the waters from every standpoint; and is of great advantage in the successful handling of such large quantities of water as necessary at the filter plant.

Bacteriological tests of these settlers have from time to time been made. Samples of the influent and the effluent waters have been taken and the total numbers of the colonies determined in the usual manner on nutrient gelatine; since October, 1899, the tests have been made about twice a week. From the following table of the results it will be noticed that there is considerable variation in the raw water in bacterial content, but that there is almost always some diminution of the organisms due to this mere process of settling in the settlers. The counts are made after 72 hours unless otherwise stated:

1899.	Raw water.	Settled water.	1900.	Raw water.	Settled water.
Oct. 16	2,216	1,936	Jan. 4	1,800	1,360
" 19	1,056	704	" 8	1,240	1,200
" 23	1,095	776	" 15	3,840	2,736
" 26	2,480	1,922	" 18	3,120	2,760
" 29	1,424	1,400	Feb. 1	1,674	1,240
Nov. 2	2,160	1,674	" 8	1,800	1,800
" 6	3,010	2,240	" 12	2,356	2,052
" 9	1,800	1,050	" 15	1,860	1,512
" 13	1,200	910	" 19	2,574	2,128
" 16	1,836	1,808	" 22	8,100	6,480
" 20	1,125	1,200	Mar. 1	3,286	2,864
" 23	1,241	1,116	" 5	11,718	10,044
" 27	1,480	1,856	" 8	10,044	8,928
Dec. 4	1,320	1,200	" 15	15,068	12,834
" 11	16,200	10,800	" 26	4,092	3,472
" 14	13,500	10,560	" 29	3,120	3,024
" 18	12,400	8,000			
" 26	2,912	2,760	Av'rge (Ed.)	4,240	3,420

The above data are given just as they run from the laboratory, not being selected data beyond that on any given date they may represent the highest and lowest numbers obtained.

There have been a large number of chemical analyses of the waters at the canyon made, but on tabulating them I find that few of them show the difference between the raw and the settled water; the analyses were made to find the action of the filters on the raw or the settled water, and so the comparisons cannot be made, as they show the raw and settled waters on different dates. On two different occasions the comparative analyses can be shown:

	Aug. 8, 1896. Raw.	Settled.	Sept. 9, 1899. Raw.	Settled.
Free ammonia	0.030	0.020	0.012	0.001
Aluminoid ammonia	0.070	0.064	0.056	0.062
Nitrogen as nitrites	0.000	0.000	....	....
Nitrogen as nitrates	0.000	0.000	0.000	0.010
Oxygen consumed on boiling with potassium permanganate for 10 minutes	2.70	2.500	3.000	2.800
Color (Hazen)	....	....	0.120	0.040

The river water on these two dates happens to be so free from foreign matters that the data are not very striking; the oxygen consumption and the color being as marked as anything.

FALLACIES IN GOOD-ROAD ECONOMICS.*

By Ira O. Baker, M. Am. Soc. C. E.†

There has been no lack of literature concerning the advantages of good roads; but some of it has done more harm than good, since its extreme views and fallacious arguments have antagonized many of those whose cooperation must be enlisted before any considerable improvement of the condition of the public highways can moment can be secured unless the farmers and land owners believe the arguments and trust the motives of the advocates of good roads.

It is proposed to examine the arguments of some of the more prominent advocates of road improvement, with a view of determining the limitations as to permissible cost.

A WILD GUESS.

A favorite method of showing the wastefulness of bad roads is to compare the efficiency of horses on European and American roads. Some claim that a horse in Europe does twice as much work as in America, solely because of the better roads; while others claim that three horses in Europe do as much as four in America. The annual cost of bad roads to the American farmer is then said to be the annual cost of feeding one-quarter to one-half of all the horses in America plus the annual interest on the value of the superfluous horses. The results are truly appalling.

In the first place, the premise is a mere guess, since it is impossible off-hand to state the relative efficiency of horses in Europe and in America. Doubtless there are poor roads in Europe, and there are surely some good ones in America.

In the second place, the above line of argument assumes that all horses are continuously upon the road. This assumption is seriously in error, since there are a large number of horses in the cities not in any way connected with the farms, and farther since the horses on the farms include a number too young to work, and still farther since most farmers require considerably more horses to raise the crops than to transport them to market.

Is it surprising that such arguments fail to convince the farmer of the disastrous cost of bad roads? It is astonishing that such estimates were ever seriously proposed. They are unworthy of further consideration, and are referred to here only because they are frequently quoted.

A ROUGH ESTIMATE.

Another favorite method of demonstrating the cost of bad roads is to estimate the saving per horse due to improved roads. The annual saving per horse is variously estimated at from $10 to $20, and the saving in vehicles and harness is estimated as equivalent to $5 per horse, making a total annual saving by good roads of $15 to $25 per horse.* This sum is then multiplied by the number of horses given in the census report or returned by the tax assessor, and the product is said to be the annual loss by the farmers due to bad roads. Using the smaller of these values, one author makes the annual loss in Illinois $15,000,000, equivalent to $272 for each square mile in the state.† Is this result even approximately correct?

1. No evidence is offered to show the actual loss by bad roads. Possibly a horse continually on the road could earn $10 to $20 per year more on good roads than on poor ones. But, on the contrary, farmers frequently claim that the damage to a horse through driving on "good roads,"

*Condensed from a paper printed in "The Technograph."

†Professor of Civil Engineering, University of Illinois, Champaign, Ill.

*Problems of To-day, Richard T. Ely, 1890, New York, 3d ed., p. 148. Road Legislation for the American State, Jeremiah W. Jenks, Baltimore, 1889, p. 14. Report on Highways of Maryland, 1899, Baltimore, p. 410.

†Road Legislation for the American State, p. 14.

i. e., on stone roads, is more than $15 per annum. "The hard roads stiffen up a horse." The cost of keeping a horse shod is considerably more with stone than with earth roads. These losses due to good roads are reasonably certain, while the advantages claimed are problematical. Possibly the damage to vehicles and harness is more with poor than with good roads; but farmers claim that vehicles wear out faster on stone than on earth roads. In short, the advantages are not all on one side, and the saving claimed is not proven.

2. Even though a horse continually on the road could and would earn $15 per annum more on good roads than on poor ones, the above estimate is grossly in error, since only a small per cent. of the horses are on the road all the time, or since the average horse is on the road only a very small part of the time. Unquestionably a horse can do more work on good roads than on poor ones, but that does not prove that farmers, gardeners, etc., as a rule, would require fewer horses or that their horses would earn more with better roads.

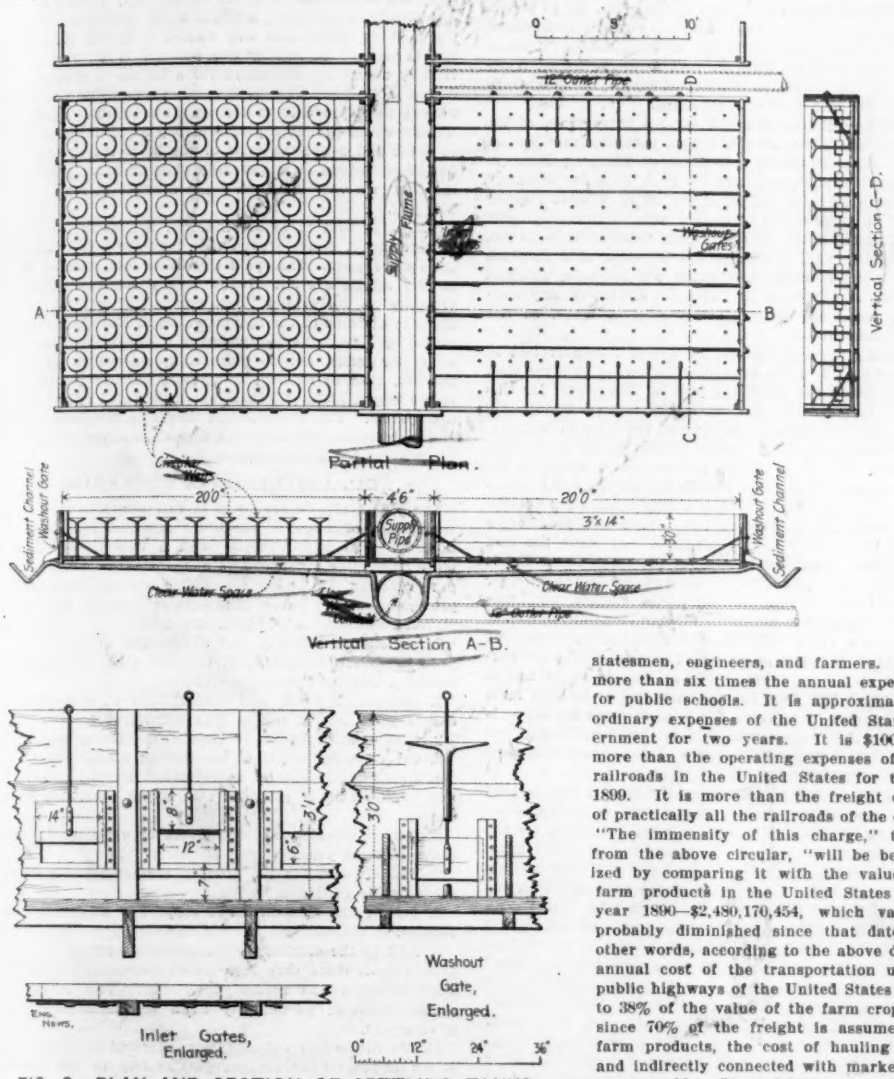


FIG. 2.—PLAN AND SECTION OF SETTLING TANKS.

STATISTICAL COST OF WAGON TRANSPORTATION.

The Office of Road Inquiry of the United States Department of Agriculture, in Circular No. 19, as a result of "ten thousand letters of inquiry sent to intelligent and reliable farmers throughout the country," presents the statistics in Table I. as to the length of haul, weight of load, cost per ton mile, and cost from farm to market. The table "represents the consolidated report from about 1,200 counties."

TABLE I.—DATA ON COST OF BAD ROADS.

Ref. No.	Locality	Average Haul—Distance, miles.	Average Haul—Load, tons.	Cost, ton-mile, cts.	Total cost per ton.†
1	Eastern States	5.9	1.108	32	$1.89
2	Northern States	6.9	.....	27	1.86
3	Middle-Southern States*	8.8	.....	31	2.72
4	Cotton States	12.6	0.688	25	3.05
5	Prairie States	8.8	1.204	22	1.94
6	Pacific Coast & Mountains.	23.3	1.098	22	5.12
7	Whole United States....	12.1	1.001	25	$3.02

*In one place in the circular, designated "Middle States," and in two places "Middle-Southern States." Unquestionably the two terms apply to the same region.
†From farm to market.

The circular determines that in 1895 the farm products amounted to 219,024,277 tons; and assumes that the farm products consumed on the farm are offset by the mine and quarry products, merchandise, etc., hauled over the public roads. It is farther assumed that one-quarter of the timber cut for fuel and for the mill, and all of that used by the railroad, or a total forest product of 93,525,000 tons, is transported over the public highways. The conclusion is then reached that in 1895, 313,349,227 tons were hauled over the highways of the United States at a cost per ton of $3.02 (the "cost from farm to market"), making a total cost of wagon transportation of $946,314,665.54.

If the cost of transportation on the wagon roads of the country is $946,000,000 annually, then indeed is highway improvement worthy of the most careful attention of statesmen, engineers, and farmers. This is more than six times the annual expenditures for public schools. It is approximately the ordinary expenses of the United States government for two years. It is $100,000,000 more than the operating expenses of all the railroads in the United States for the year 1899. It is more than the freight earnings of practically all the railroads of the country. "The immensity of this charge," to quote from the above circular, "will be best realized by comparing it with the value of all farm products in the United States for the year 1890—$2,480,170,454, which value has probably diminished since that date." In other words, according to the above data, the annual cost of the transportation upon the public highways of the United States is equal to 38% of the value of the farm crops. Or, since 70% of the freight is assumed to be farm products, the cost of hauling directly and indirectly connected with marketing the crops is 38 × 70 = 26.6% of the value of these products. According to the report of the eleventh census, there are 5,442,756 farmers, planters, dairymen, gardeners, florists, nurserymen and vine-growers in the United States, and therefore the above cost of transportation is equivalent to $157 for each "farmer." Again, according to the census the area of the farms is approximately 1,000,000 square miles; and therefore the above cost of transportation is $946 per square mile, or $1.48 per acre, which is more than one-fourth of the annual rent of farm lands. Is this conclusion approximately true?

The above data is the result of an earnest and comparatively elaborate attempt to throw light upon a complicated question materially affecting the entire population of this country; and therefore the methods employed and the results obtained are worthy of a careful and detailed examination.

While the examination about to be entered upon is primarily to determine the cost of transportation upon wagon roads, incidentally it will illustrate some of the principles to be employed in deducing conclusions from statistics. The incidental purpose is worthy of a far more careful discussion than can be given to it in this connection.

ELABORATENESS OF THE INVESTIGATION.—Owing to its seeming elaborateness, the above official investigation has carried great weight—witness the following from a state highway commission: "Although any one result may be considerably in error, the average of so many must be quite reliable." The statement that ten thousand letters of inquiry were sent out, apparently creates the conviction that the investigation was a very elaborate one. The area to be covered was also very great; and the inquiries averaged only one to 300 square miles—or say about three inquiries to two counties. This shows that the attempt was not on a very elaborate scale. The writer has inquired and has been officially informed that it is not known how many answers were received. The statement is that Table I. "represents the return from about 1,200 counties," or about one county in twenty-five. This shows that the number of answers was entirely inadequate to secure representative data for the whole country. Farther, the value of the answers will depend greatly upon their distribution. Inquiry has been made, but nothing can be learned of the distribution of the answers. However, the circular prints twenty-six replies of "representative men," of which eighteen, or 69%, are from New Jersey. If the replies were bunched in anything like this proportion, then some parts of the country are indeed meagerly represented in Table I. At best, data for one county in twenty-five can not be accurately representative.

AVERAGE HAUL.—The value of the reply as to the average haul will depend upon the manner of determining it. "The Road Inquiry Office has no copy of the letter of inquiry." Apparently the letter merely asked for the average haul, and gave no instructions as to the method to be used in deducing it. A man on receiving such an inquiry and knowing that farm products were hauled to a certain town from all distances up to ten miles, would probably reply that the average haul was one-half of 0+10, or 5 miles. By many trials, the writer has found that in the great majority of cases this answer is accepted as correct; while in fact it is erroneous, and in many cases greatly so. This method of determining the average haul does not take into account the number of loads hauled each distance.

1. The correct determination of the average haul for any particular place is a complicated matter. To illustrate the difficulties, let us assume that the number of tons per acre is the same for all distances. For a certain distance out from a railroad station all of the land is tributary to this particular station, and hence out to this limit the number of tons hauled will vary as to the square of the distance. Beyond this limit only part of the land is tributary to this particular station, and consequently as the distance increases the number of tons decreases and finally becomes zero. This method of solution assumes that a road runs directly, i. e., diagonally, from the farm to the station; but as a rule the roads run only on the cardinal lines.

2. The distance hauled will vary greatly with the locality. Farm products will be hauled much farther to a large city than to a small village; certain kinds of products will be hauled much farther than others; and the distance hauled will vary greatly with the kind of roads. If the letters of inquiry were sent to large cities where a considerable part of the freight traffic on the public highways was hauling vegetables, fruit, etc., over good stone roads to market, then the result for the average distance hauled, even though correctly determined, is of but little value in determining the cost of hauling the average farm product to market. The writer could learn nothing about the distribution of the letters of inquiry; but in the circular giving the results of the investigation are published a number of "opinions of representative men," of which 69% are from New Jersey. Doubtless a considerable part of the traffic in New Jersey is hauling perishable products on good roads to large towns and cities; and hence does not represent average conditions. Farther, a disproportionate per cent. of these replies are from large cities. Obviously the value of the individual replies will depend upon the points from which they came.

3. The value of the average of several replies will depend upon the distribution of the replies. One part of the state furnishes more traffic and is better supplied with railroads than another. The replies should be distributed proportionately to the amount of traffic.

The above facts show some of the errors which vitiate the results. The problem is such that a farmer could not be expected to determine a result with any considerable accuracy for any particular place; and the nature of the investigation is such that a multiplicity of results does not insure a correspondingly accurate average.

The designation of the territories covered by Table I. is too indefinite to permit a direct test of the data; but an examination of a railroad map shows that probably the average haul as given in Table I. is considerably too great—at least for the states that furnish the bulk of the traffic. Portions of a state may be found which are relatively at a considerable distance from a railroad station, but in nearly every case it will be found that throughout that area there is but little traffic on the public highways.

The reliability of the value of the average haul as given in Table I. can be approximately tested in another way. For example, Illinois has an area of 56,000 square miles, and has 10,752 miles of railways exclusive of sidings and second tracks; or 1 mile of railroad for each 5.3 square miles of area. Investigations also show that the distance between railroad stations averages a trifle under 4.5 miles. Therefore, if we consider a strip of land 5.3 × 1 miles laid transversely across the railroad half way be-

tween railroad stations, then the maximum haul will be approximately ½ of 5.3 + ½ of 4.5 = 4.9 miles. This may be regarded as the average maximum distance of haul in Illinois. The average haul is probably approximately half this, or say 2.5 miles. There is a slight error in the above computation, since no account is taken of the fact that the railroads cross each other; and this error makes the result slightly too small.

By the preceding method of solution the average haul for Iowa is slightly less than that for Illinois; while that for eastern Kansas and eastern Nebraska are a little greater than for Illinois. Illinois, Iowa, eastern Kansas and eastern Nebraska furnish the bulk of the traffic from the "prairie states," and hence we conclude that the value of the average haul as given in Table I. for the "prairie states," 8.8 miles, is perhaps three times too great.

Finally, notice that 30% of the freight supposed to be hauled on the wagon roads is forest products, and therefore "the distance from farm to market" has little or nothing to do with this part of the traffic.

AVERAGE WEIGHT HAULED.—The weight of the average load varies chiefly with the grade of the road and condition of its surface; and in most localities the latter varies greatly with the season, and is not the same for any two successive years. Farther, with earth roads the most of the freight is hauled when the roads are in their best condition. For these reasons, it is a matter of considerable difficulty to determine the weight of the average load for any particular place, much less for an average of several states. However, as this data is not directly used in determining the supposed cost of bad roads, this phase of the subject will not be discussed farther.

COST PER TON-MILE.—No details are given as to the method employed in determining the cost per ton-mile of hauling crops from the farm to market. The prices given indicate that the wages of a wagon, team and driver were assumed to be about 35 cts. per hour; that the load was assumed to be approximately 1 ton; that the team was assumed to travel about 3 miles per hour; and that the team was assumed to haul a load only one way. There are three radical errors in this method.

1. The price per day is too great or the amount hauled per load is too small. The writer has considerable knowledge of the prices actually paid for hauling on Illinois roads, and believes that the prices in Table I. are the maximum rather than the average, and are perhaps a third too high.

2. The great bulk of teaming is done when the roads are at least in fair conditions, when the load is considerably more than 1 ton. In fact, there is very little of the crop hauled to market when the load is one ton or less. The writer has examined the records of several grain buyers in central Illinois, where at times the roads are as bad as anywhere, and finds that the average load is nearly a ton and a half.

3. The most important error in the whole investigation under consideration is the assumption that the chief business of the farmer is transporting his crops to market. The great bulk of farm crops is hauled to market when the farmer has nothing else to do, or when it is not a matter of much moment whether other work is delayed; and in this case the cost is merely nominal.

In many localities there is a choice of markets; and in central Illinois it is nothing uncommon for a farmer to haul corn four to six miles extra for a difference of 1 ct. per bushel Thirty-six bushels make a ton, and therefore he receives 36 cts. per ton for the extra hauling, or say 6 to 9 cts. per ton-mile. This result is approximately one-third of that in Table I.

The results in Table I. for the cost per ton-mile may be approximately correct for gardeners, dairymen, etc., who are compelled to keep a team upon the road nearly every day of the year; but these are not representative "farmers," for according to the eleventh census of the United States there are 5,281,557 farmers and planters, and only 90,470 gardeners, dairymen, florists, nurserymen, and vinegrowers. Again, the writer has frequently asked grain farmers: "What is it worth to haul crops to market?" and in a great majority of cases has received answers substantially as in Table I.; but on asking: "What does it really cost you?" the answer is almost invariably: "Nothing." The average farmer is not conscious that it costs him anything to haul his crops to market.

THE AMOUNT HAULED.—In the computation of the cost of wagon transportation, the circular referred to above assumes that the farm products consumed on the farm were offset by the hauling of lumber, coal, fertilizers, merchandise, etc., to the farm. In the first place, it is doubtful if there are as many tons of freight hauled to the farm as there are of products consumed on the farm. In the second place, the offset ought not to be allowed, since almost always the freight hauled to the farm is brought back when a load of produce is taken to town, or is hauled back incidental to a trip for some other purpose, or is hauled when there is nothing else to do. In the third place, a considerable part of the farm product is driven to market on foot.

CONCLUSION.—Above it has been shown for Illinois (1) that the average haul is probably less than one-third of that given by Table I.; (2) that the cost per ton-mile is not more than one-third of the value given in Table I.; and consequently for Illinois the average cost from farm to market is only about one-third of one-third, or one-ninth, of that stated in the table.

In the light of this conclusion, it is astonishing that the results from the circular under review have so frequently been used with approval in newspaper and magazine articles, in public addresses, in governor's official messages, in resolutions by boards of trade, and in books on road improvement. When such arguments are the chief stock in trade of would-be road reformers, is it any wonder that farmers are indifferent? They instinctively know that conclusions such as those deduced above from Table I. are ridiculous, and not unnaturally distrust the motives prompting the argument, and are hostile to all propositions for road improvement.

"DEFINITE SAVING BY GOOD ROADS."

The Office of Road Inquiry, in Circular No. 19, as above, estimates the possible annual saving by road improvement as two-thirds of $943,314,665.54, or $628,000,000. This is equal to an average of $105 for each farmer, planter, fruit-grower, gardener, etc., in the United States; or an average of 78 cts. for each acre of farm lands.

The above estimate is based upon a comparison of the data in Circular No. 19 above with that on the "Cost of Hauling Farm Products to Market or Shipping Point in European Countries, Collected by U. S. Consular Agents," published in Circular No. 27 of the Office of Road Inquiry of the U. S. Department of Agriculture. The average cost as given in the latter circular (when translated) is 10 cts. per ton-mile, and the difference between this and the average stated in Table I. is 15 cts. per ton-mile, which is two-thirds of the total in Table I. Evidently any conclusions based on Table I. are greatly in error, as has already been shown.

Apparently the average cost of wagon transportation in Europe as stated in the preceding paragraph is more than that deduced in the preceding part of this paper, for this country. In the first place, the statistics from Europe are open to the criticisms made against the data in Table I. In the second place, the twelve results given in the circular vary from 4 to 30 cts. per ton-mile, which is too wide a range and too few results for an accurate determination of the cost of wagon transportation in Europe. In the third place, some of the results are professedly the cost to transportation companies, and some the cost to farmers to whom the hauling of the crops to market is merely an incident of farm work. And finally the data for the cost of hauling not done by transportation companies is for hauling garden products, etc., to large cities, and is therefore not representative of the cost of transporting general farm products to market. The cost of wagon transportation on the very best roads of Europe ought not to be very much less than the ordinary cost of hauling farm crops to market in America, for in most cases the latter is done when the roads are in fair or good conditions, and when in their best condition earth roads are nearly as good as the best stone roads.

The above method of estimating the saving due to good roads is materially in error, if not very deceptive, since no account is taken of either the annual interest on the original investment or of the increased cost of maintaining the better roads. Of course, these items will vary greatly with the location and character of the road and with the amount of traffic; but this is no reason why they should be omitted in such estimates. An elaborate official report* in making "an approximate estimate of the actual amount of money that would be saved annually by good roads" neglects these items, when on a preceding page† it had been shown that the original cost of the roads of France varies from $12,880 to $2,580 per mile, and the annual cost of maintenance varies from $258 to $64, respectively. Of these higher-priced roads, "national roads," there is one mile for each 8.7 square miles of territory; and of the lower-priced roads, "neighborhood roads of the lowest grade," 1 mile for each 1.3 square miles of area. The original cost of the national roads of France is $12,880 per linear mile of road or $1,480 per square mile of tributary area, which at 5% interest is equal to an annual charge of $644 per linear mile of road, or $74 per square mile of territory. The cost of maintaining these national roads is $258 per linear mile of road, or $30 per square mile of territory. Therefore the annual cost of these celebrated roads is: $644 + $258 = $902 per linear mile of road; or $74 + $30 = $104 per square mile of territory. Similarly, for the lowest grade of neighborhood roads the annual cost is: $129 + $64 = $193 per linear mile of road; or $100 + $50 = $150 per square mile of territory. The greater mileage of the cheaper roads makes the cost per square mile of benefited area greater than for the better roads. At 5% interest the annual cost of all the wagon roads of France is: $400 for interest plus $180 for maintenance, or a total of $580 per square mile of area. Clearly then the interest on the original cost and the expense of maintenance are important elements and should not be omitted.

ROAD TAXES WASTED.

It is frequently argued that because the annual road tax produces no hard roads that therefore at least a large part of the money is wasted. 1. In most states part of the tax is spent for new steel bridges. In Illinois a little more than one-quarter of the road tax is so spent. Steel bridges are a substantial improvement, and would be almost imperative with stone roads. 2. Another considerable part of the taxes is used in renewing wood culverts and the floors of bridges, which expense would be practically the same whether the roads are improved or not. 3. A further sum is spent in improving the drainage, which would be required before good stone roads could be built. 4. Part of the road taxes is used to pay for mowing the roadsides, which would be desirable even if the road surface were improved. 5. Finally a considerable portion of the money is used in maintaining the surface, and if the roads were improved, a considerably larger sum would be required for a like purpose.

The claim is frequently made that a large part of the labor tax is wasted. Possibly in the early history of any community, when there is slight social intercourse among the farmers, more time was wasted in gossip than now; but at present the loss by this practice is not very great. It is by no means uncommon for a farmer to give considerably more labor than is exacted; he uses the roads and desires to improve them for his own benefit. Farther a farmer would probably prefer to pay $2 in labor than $1 in cash; and hence the evils of the labor tax system may not be as serious as is generally claimed, since practically the farmer's vote determines the amount of road tax he will pay.

Admitting that there are inherent defects in the labor-tax system, it is not proven that they are greater than in the cash system. Cash-paid day labor and contract work in city affairs are not always ideally efficient. There is probably no universally "best system" of maintenance of highways. Some of the famous roads of Europe are maintained by a cash-tax and some by a labor-tax. There are no better roads, nor no more complete system of maintenance, than in France; and yet by far the greater part of the wagon roads of France are maintained by the labor-tax system. The fundamental defect in the construction and maintenance of American highways is the lack of intelligent and effective supervision.

REAL ADVANTAGES OF GOOD ROADS.

The object of this article is to call attention to the extravagance of some of the more common arguments in favor of road improvement, with a view of securing a more reasonable consideration of the matter. Incidentally, the preceding discussion shows that any considerable improvement of the public highways can not in general be justified entirely on financial grounds.

In conclusion some of the advantages of permanently good roads are as following, the first eight of which are financial and the last six are social:

1. Decrease the cost of transportation—at some seasons only a little, and at others very considerable.
2. Give a wider choice of time of marketing crops.
3. Give a wider choice of the market place.
4. Decrease the cost of miscellanous travel.
5. Permit sale of products that might otherwise go to waste.
6. Tend to equalize railroad traffic between the different seasons of the year.
7. Tend to equalize the produce market between different climatic conditions.
8. Permit the cultivation of crops not otherwise marketable.
9. Add to the comfort and pleasure of travel.
10. Permit more easy intercourse between farmers, and between rural and urban populations. This is an important benefit, particularly in a republican form of government.
11. Facilitate the consolidation of rural schools. This is an important advantage, particularly to the coming generation.
12. Facilitate rural mail delivery.
13. Improve the sanitary condition, particularly in villages and towns.
14. Improve the appearance of the highway.

It is customary to include the increase in the price of land as one of the advantages of good roads; but the increase in price of land is simply the measure of the value of all of the above advantages, and hence should not be included.

By inquiry among farmers and real estate agents, it appears that in the corn belt of Illinois, farming land 1 mile from a railroad station sells for $5 to $10 per acre more than land 5 miles farther away. In other words, this is approximately the grain farmer's estimate of both the financial and the social value of good roads. Strictly, the above sum is a little more than the supposed value of good roads, for no form of improved road can ever put the more remote locality upon exactly the same basis as the nearer one, for even the best road can not eliminate the difference in distance. Either of the above sums is too small to justify any radical highway improvement.

Too much attention has been given to the supposed direct financial advantages of good roads, to the exclusion of the social advantages. Good roads are desirable for the same reason that a man buys a carriage or builds a fine house, i. e., because they are a comfort and a pleasure. Good roads are to be urged for the same reason that good schools are maintained, i. e., because they increase the intelligence and value of the citizen to society.

Farther, more attention should be given to the improve-

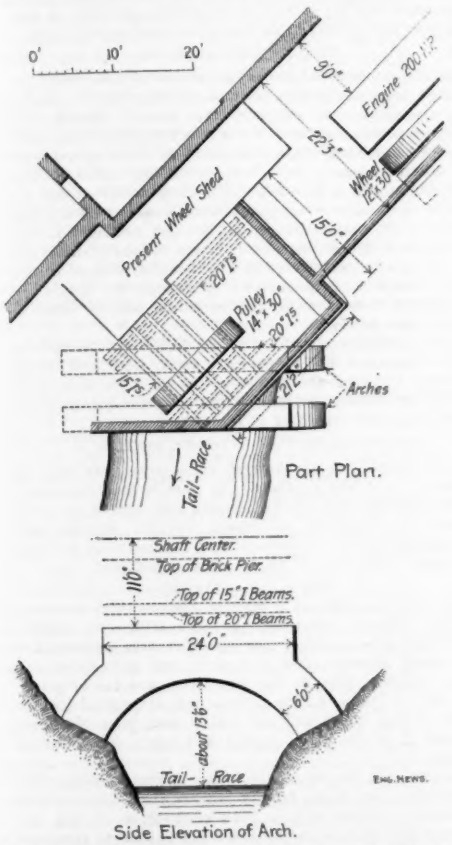
*Report of the Highways of Maryland, Baltimore, 1899, p. 408-9.
†Ibid., p. 385.

ment of the present earth roads, and less to the advantages of roads which at present are impossible to many rural communities. Good roads will come by evolution rather than by revolution; and the improvement of earth roads is always the first step toward any kind of better roads.

A NOVEL METHOD OF SUPPORTING A BUILDING OVER A RUNNING STREAM.

The accompanying illustrations show an ingenious solution of a rather troublesome problem in mill construction, recently made by Mr. Chas A. Hague, M. Am. Soc. M. E., 39 Cortlandt St., New York, in connection with some extensions of the plant of the New York Rubber Co., at Matteawan, N. Y.

The very low water in the streams this season has more or less restricted the output of mills and factories dependent entirely upon water-power, and the above-named company decided to supplement their water-power with steam. In order to run the mill either by steam or by water-power, or by both together at will, it was planned to belt a Corliss engine to a large pulley mounted upon a quill shaft provided with a friction clutch, and



Side Elevation of Arch.

Partial Plan and Elevation, Showing Method of Supporting Auxiliary Steam Drive over Tail Race, New York Rubber Co.'s Works, Matteawan, N. Y.

Chas. A. Hague, M. Am. Soc. M. E., Chief Engineer.

thus to connect the steam-power when desired to a jack-shaft which passed through the quill and coupled directly to the main shaft of the mill near the point of the water-wheel drive. By this arrangement, the throwing out of the friction clutch left the mill completely under the control of the water-wheel, and left the engine simply belted to an idle quill shaft and with no connection with the mill.

During the night the dam fills up and full water-power is available for a few hours in the morning; but when the water has fallen low enough to cause a deficiency of power, the engine is started, the friction clutch thrown into the drive, and the automatic cut-off of the steam engine controls the exact balance of power necessary to maintain proper speed, while at the same time the mill is utilizing all of the water-power that may be available.

A small building had to be provided to enclose and support the quill, jack-shaft, driving pulley, clutch, and pillow-blocks. There was no possible location for this building, however, except directly over a tail-race outside the mill. This tail-race was located in a sloping channel in rock, about 30 ft. below the level of the floor of the main building; and the value and occupation of the floor space within the factory absolutely forbid the placing of the new machinery inside the building. The usual solution of such a problem would be to bridge over the tail-race with a heavy masonry arch or tunnel, carrying the masonry up to the floor level. Another solution would be to bridge the race with steel trusses. Both of these methods, however, were rejected as being too expensive, as the peculiar angle and situation of the tail-race were extremely awkward for such plans; and the method shown in the drawings was adopted instead. Two light arches of brick, only 3 ft. thick, were built across the tail-race, its sloping sides forming their skewbacks, and a flat-topped wall, 24 ft. long, was built on each side. These walls formed a support for a series of six 20-in. I-beams, three of which, 14 ft. long, were laid diagonally across the arches and square with the center line of the jack-shaft; the other three beams, 24 ft. long, were laid parallel to the first three, from one end of the westerly arch wall to the extension of a pier already in place at the head of the tail-race. Across these six beams, and parallel with the center line of the shaft, were laid five 15-in. I-beams, which carry the floor of the building and the brick foundations of the pillow-blocks for the quill and jack-shafts. A portion of the building wall is also carried on one of the arches, as shown in the drawing.

The weights of the driving pulley, shafts, pillow-blocks, and walls are distributed so as to load the arches as uniformly as possible; and the loads upon the I-beams are reduced to about one-half of the usual allowance for such members. The jack-shaft is 8 ins. in diameter, and 15 ft. long; the friction drive is made by a 54-in. Hill clutch; the quill is 13 ins. outside diameter and the hole through the center is 8½ ins.; the driving pulley, which is the driven pulley from the engine, is 14 ft. diameter and 32 ins. face; the quill and jack-shaft are of forged steel from the Bethlehem Works. The disposition of the auxiliary machinery is such that the entire water-power outfit may be removed and refitted while the factory is operated by the steam engine alone, and this was one of the objects in view.

In passing it may be of interest to know that there is a knotty legal problem in water-power rights looming up in this neighborhood, on account of an electric light plant some distance upstream, which is idle nearly all day, with its headgates shut, and runs at night when the tail water runs to waste, after filling the dams below. The result is that in a dry season like the present one, the lower powers are short of water during regular daytime working hours, and at night or early in the morning the water runs to waste.

THE INVESTIGATION OF GAS PROCESSES.*

By A. C. Humphreys, M. Am. Soc. M. E.†

Having recently been called to the Pacific Coast to make an investigation of the Hall gas process‡ and having in the course of my work met with the usual difficulties and dangers, it occurred to me that a subject was here suggested which afforded me the opportunity of complying with the repeated requests from your officers for a paper. Apparently a few words of warning may not be without value, for it does not seem to be generally understood, even amongst gas engineers, that the investigation of a new process is a thing to be taken up cautiously and with a due sense of personal responsibility.

For 25 years I have been called upon to investigate the claims of gas processes, and in a majority of cases a detailed examination was not required to convince me that the claims made by the promoters were impossible of fulfilment. This suggests the first danger; namely, that we may become so accustomed to not finding merit that we may be influenced to reject meritorious cases without adequate investigation. Here we must learn that while we can, and should, avail ourselves of our experiences to better safeguard us against ignorance and fraud, we should be careful to bring to each case a mind open to conviction. In many cases within my experience the claims were manifestly so impossible of fulfillment that not only was an investigation unnecessary for my own information but it was also unnecessary for the guidance of my clients. In these cases, however, it has not infrequently been found necessary to make an exhaustive and expensive investigation to be in a position to better satisfy the investing public and the municipal authorities, who generally are not competent to form a correct judgment except through a simple comparison of working results.

Unfortunately, it is not sufficient that we who are chiefly interested should know the facts, but we must be prepared to convince both those who are incapable of understanding, and those who are unwilling to accept, arguments and demonstrations based upon the established laws of science. The instance referred to in my opening was a case in point. The claims made for this process were known by my clients and me to be incapable of verification; but others had to be convinced, and, as the claims were based upon commercial results said to have been obtained in San Francisco, it became necessary to make a critical examination on the ground.

A GREASED WIND PROCESS.

In one notable case, about 15 years ago, I was called upon to investigate a process which was making a stir in the gas world, and as usual one or two gas engineers had been induced to lend the process some support. One of the claims made for the process was sufficient to condemn it, but as the promoters were able to show letters of endorsement from two prominent professors, as an influential stockholder in my company had become convinced of the validity of the claims, and the contemplation of the fabulous wealth to be realized from his small investment, if the claims were verified, had temporarily impaired his judgment, it was found necessary to make a complete test in order that the truth might be more readily demonstrated.

The claim referred to was that from a barrel of crude oil 250,000 to 500,000 cu. ft. of gas could be produced, equal in quality or superior to the city gas as ordinarily supplied, and that after extracting this volume of gas from the oil there would remain "nearly a full barrel of oil," which, by the treatment, would be so improved in quality as a lubricant that it could be sold for more than the full barrel originally cost.

It is sometimes well to reduce such absurdities to actual figures. Assume 300 lbs. as the weight of the full barrel of oil and 21,000 British thermal units per pound of oil. Take the quantity of gas produced as that of the lower limit, and assume 650 British thermal units per cubic foot as being a fair average for city gas:

300 lbs. of oil at 21,000 gives.....	6,300,000 B. T. U.
250,000 cu. ft. gas at 650 gives	162,500,000 "
Deficit	156,200,000 "

So, assuming that all the oil were converted into gas, reserving none of it for sale as a lubricant, according to the claim, there was a gas product obtained which contained 156,000,000 more heat units than were originally contained in the barrel of oil from which the gas was produced. The right to operate this process for certain states was valued by the promoters at $25,000,000. The exclusive rights to such a perpetual motion scheme were cheap at the price.

The fact that favorable opinions were obtained by the promoters from two well-known and reputable professors points to a danger of a very grave character. Here were two scientists, professors in one of the best of the engineering institutions, apparently vouching for the truth of the claims made. Were their statements as made correct? Probably they were, but neither statement was complete. One certificate simply stated that a certain volume of gas was made from a certain quantity of oil, and the other certificate stated that the gas examined had certain photometric and calorific values. When read together, as intended, it was natural that the assumption should be made that both statements referred to the same test; such was not the fact. One investigator saw a certain quantity of material consumed, and saw as a result a certain volume of gas pass through the meter and gave a certificate to that effect. The other investigator, on another occasion, saw gas being produced, and the quality was tested without regard to the quantity of oil used or volume of gas produced and gave a certificate accordingly. As the process was one of the "greased air" class, it is easily seen that in the volume test there was no difficulty in getting the result desired, provided there was no coincident examination for quality. The volume of gas produced was only limited by the volume of air blown through the apparatus. When the test for quality was made the air was restricted and oil was used without stint.

It is a lamentable fact that some of our professional men can be misled into making these partial statements, and some of them are greatly grieved if in consequence their integrity is later called in question. The statement should go unchallenged that such incomplete, unguarded certificates are either the result of a willingness to deceive, of culpable carelessness or of lack of common sense. Certain it is that such certificates should be discredited.

*A paper read before the Pacific Coast Gas Association, July 11, 1900.

†Consulting Gas Engineer, 31 Nassau St., New York city.

‡For other information concerning the Hall gas process see Eng. News, Dec. 7, 1899; Feb. 15, 1900; May 3, 1900.

The only way I know of to avoid danger in this connection is by refusing to accept the endorsements of any except those who we personally know to be qualified by training, experience and character to give a reliable opinion on the particular question involved.

In making our test of this "greased air" process my force was constantly at work for six weeks trying to measure the gas produced from a given quantity of oil and to determine the average photometric and calorific values of this gas. The vessels which received the oil, and through which the air was blown, were boiler shells with heads and bottoms riveted on, the only openings being the connections for oil and air. It was, therefore, difficult to determine whether the oil admitted to the carburetting vessels had been all absorbed and also to prevent the surreptitious admission of oil when our men were off guard. The regular oil admission pipes were located and brought under our control, but we still had reason to doubt the accuracy of some of our results. Our watchfulness was finally rewarded by the discovery of a small pipe attached to one of the carburetting chambers, and this pipe was evidently used for the unauthorized supply of oil to the apparatus. The valve on this pipe was closed and sealed to prevent all tampering, and preparations were completed for making the final test the next day. That night the experimental works mysteriously took fire and the apparatus was so disabled that the test could not be completed. But we had done enough to disprove the claims made, and my assistants in charge obtained an experience which served thereafter to effectually put them on their guard against doctored results, and we all had learned to regard with suspicion partial certificates covering isolated steps of a process.

DECEIVING STATEMENTS BY PROMOTERS.

A favorite form of statement employed by promoters and patent enthusiasts is that their process will cut the cost of gas in half. In such cases it is well to require the promoter to show upon what basis of established practice he expects to show his saving of 50%. As a rule it will be found that he is making his comparisons with practice which is or should be obsolete, and that he is ignorant of what constitutes present good practice.

It will almost invariably be found upon cross examination that the extravagant claims made for a new process are not even based upon any complete test. Almost without exception when I have started to test these experimental installations, I have found that no provisions had as yet been made for a complete determination of manufacturing results. One or more of the pieces of apparatus required for measuring the material used and the gas produced have been wanting, and it was at once apparent that the claims made, said to be based upon results actually obtained, were simply based upon crude estimates and the inventor's hopes.

GUESSING vs. MEASURING.

It has been a most common experience to find no station meter in use, and it has been quite rare to find a bar photometer, a calorimeter or apparatus for chemical analysis. And further, where such apparatus has been found it has generally been determined upon test to be defective and unreliable. Sometimes these deficiencies have been the result of incompetence, inexperience or carelessness, and sometimes they have been the result of fraudulent intent.

One notable instance I have in mind where the inventor, a man of reputation, had been led astray by his lack of knowledge of photometry. He claimed that his method of treating gas after it left the retort resulted in an increase in photometric value of about two candles. After some years, this gentleman's works fell under my control and I discovered that his photometer was faulty in the extreme, and that it was impossible by its use to make any exact candle power comparisons.

For many years one of our well-known makers sent out photometers equipped with candle balances which were beautiful to look at and expensive to purchase, but which were absolutely valueless for the purpose for which they were intended; in fact more reliable results were obtained by discarding the balance and assuming the candle consumption to be normal.

Especial caution should be exercised in accepting statements which depend upon accurate photometric determinations. There are many men who do routine photometric work with practical accuracy who are not necessarily qualified to make photometric determinations involving conditions to which they have not been accustomed. As long as the regular course is pursued, and the object is simply to determine if the day's gas product is up to standard, there is no difficulty; but even a wide variation in candle power of the gas examined might be sufficient to completely destroy the accuracy of the test. This point has been repeatedly forced upon my attention, and two striking cases have been before me while this paper has been in preparation.

In some cases it was not difficult to convince the operators of the errors or their cause, but in many other cases the faulty methods were persisted in, showing that the operators were uninstructed as to the principles of photometry, and incapable of supplying accurate data where it is a question of applying principles instead of taking certain prescribed steps. Again, certain photometers which have been proved to be reliable for certain routine work probably will be found quite inadequate for accurate comparison where varying conditions are encountered. It is well to further bear in mind that not many of the questions which come up as to the value of a new process can be determined without involving these very points as to candle power value, and, therefore, the accuracy of the photometer and the ability of the operator are prime considerations. As a rule where I have made complete examinations of processes, I have been finally convinced that, in spite of most definite and extraordinary claims as to results actually obtained, no previous complete examination had been made.

In the case of a process at one time very prominent, we were called upon to verify or disprove claims which were revolutionary. Some of the persons interested were most respectable and responsible. They thoroughly believed in the process under their control. We took charge of the works for about six weeks. It took us some three weeks to get ready for an accurate test, as there was no station meter, no bar photometer, no reliable means for weighing the coal and for measuring the oil.

The final result was to demonstrate that the gas was costing at least double the cost claimed by the promoters. The figures in the past had been obtained by measuring the gas in the holder without correction for the temperature, which was excessive. The fact that the ruinously high apparent leakage, due to this over estimate of the make, had not attracted especial attention from the owners went simply to show how blindly investors accept statements which promise them large profits. The candle power of the gas had not been measured, but had been arrived at by a liberal system of guessing. Upon taking inventory of the oil and coal, both were found to be short, the coal to an amount almost equal to the amount charged to gas making. In other words, the coal consumed had been almost double the amount included in the promoter's statement of cost.

The same process was afterward heard from at intervals in gas association meetings, and was vouched for by a man who apparently wished to be fair and whose statement carried some weight. Some years later I had the opportunity to analyze the records at this gentleman's works also, and I found that there was no station meter in use, that the gas was made only in emergencies and sent out as part of a mixture, and there were no means of correctly estimating what percentage of the mixture should be fairly credited to this process. This gentleman and his friends later defended his course by saying that he stated the results as he believed them to be, and that he did not pretend to be a gas engineer.

I claim that this man, as the responsible head of a gas company, could not avoid his responsibility for misleading enquirers as to the value of this process by acknowledging under cross examination that he had simply stated the facts as he believed them to be, and that he did not pretend to be capable of giving an expert opinion. In spite of this later disclaimer his favorable opinion of the process had already been quite generally accepted and used as coming from a man believed to be both capable and honest.

"CONTINUOUS" PROCESSES.

The continuous process has been a favorable subject for the inventor and promoter. We are generally met with the statement that the process under consideration is peculiar in method and result, and the nitrogen supposed to be necessarily present in the product of a continuous cupola process is not present in this case, or if present is so changed in character as to be a distinct benefit instead of a drawback. The action of electricity is not infrequently claimed as giving this much to be desired result. The electricity is supposed to take hold of the inert, non-combustible nitrogen and transform it into a combustible gas. Those who dispute the claim were at once pilloried as "old-fashioned," "so-called experts," "professors," "narrow-minded opponents of progress," etc., etc. Wherever a scientific fact can be brought forward seemingly to support some portion of the promoters' claims, it is done with easy confidence, but, perhaps in the next breath, with impudent inconsistency, science and scientists are condemned because they have been found to be in conflict with some other portion of the claims.

In the Hall process previously referred to we find great prominence is given to the claim for electrical action. This process was revived and brought to San Francisco and claims were made in its behalf that were known by well-informed gas engineers to be beyond acceptance. It was a continuous cupola process, the gas being made while the air for renewal of heats was being passed through the apparatus. The stoking and coaling arrangements were supposed to be automatic, and the nitrogen in the product, as a necessary result of the coincident blowing and gas making, was supposed to be converted into a combustible gas by electric, chemico-electric or catalytic action. To support this view we were also reminded that certain well-known scientists had recently discovered that the gas we had supposed to be nitrogen, an element, was now found to be a compound of many other elements. Thus a doubt was raised in the minds of some as to the identity of that incombustible residue from chemical analysis, which is generally recorded as nitrogen even though it may contain minute quantities of other inert gases.

The skillful promoter of this process made much of this point, and it was difficult to meet him before a gallery audience, in spite of the fact that it could be shown that the discoverers of argon, crypton, metargon, neon and xenon only claimed that the total of these gases was about 1% of the atmosphere or 1¼% of the nitrogen, and all that these gases, like nitrogen, were inert and, therefore it was immaterial whether the residue from analysis was called nitrogen, argon or what not.

Here certain scientists were quoted that they might be used as allies. But when such well-konwn scientists as President Morton, of Stevens Institute, Professor Barker of the University of Pennsylvania, and others testified that the apparatus as built and operated could not produce the electrical action claimed, these gentlemen and scientists in general were held up to derision.

Usually the promoter is well equipped in one particular. He is a man of nimble wit and ready tongue, and often in a duel of words before a gallery audience he is more than a match for his opponent, who though perhaps competent and honest is not necessarily trained in controversial debate. Even when a formal hearing is had before some legislative body, the adroit promoter's superficial presentation of his subject is often more convincing than the dry facts presented by the other side. To attack a gas company is generally popular, and this assists him to create the desired impression. Where ignorance and perhaps dishonesty on the part of the advocate of a process are backed up by the ignorance or dishonesty on the part of the municipal authorities, as unfortunately is too often the case, then indeed is it important that no pains should be spared that the truth may be plainly set forth, no matter how self-evident to us that truth may appear to be.

THE HARRIS PROCESS.

Often the claims of the promoter can be completely disproved from the printed documents submitted in proof of the claims. As an example, the Harris process was boomed at one time by the use of a pamphlet, from which the two following statements could be taken by reference to different pages: 1st. One ton of coal would produce 200,000 cu. ft. of gas; 2d, the heating power of this gas would be equal to 80% of the heating power of natural gas.

These two claims taken together are sufficient to condemn the Harris or any other process, for the heating value of the product cannot exceed the heating value of the coal from which it is produced. Otherwise we should get something from nothing and perpetual motion would be within our grasp.

Good bituminous coal gives say 14,500 British thermal units per pound, and natural gas gives, say, 1,000 British thermal units per cu. ft.; 2,000 lbs. of coal, then, gives 29,000,000 British thermal units, but the gas produced from this coal, according to the claims, gives:

$$200{,}000 \times 1{,}000 \times .80 = 160{,}000{,}000 \text{ B. T. U.}$$

or 131,000,000 British thermal units more than the coal from which it was produced. In spite of this most apparent weakness this Harris process was backed by many well-known bankers, politicians, doctors, lawyers and statesmen, and its promoters were successful in interesting many who could ill afford a bad investment.

THE HALL PROCESS.

The Hall process had a similar, though more extended, record. Though repeatedly proved a failure in practice, new fields were invaded, new investors were enthused and the battle between truth and error had to be again and again fought. Here in San Francisco, and the neighboring city of Oakland, the process was introduced and, in spite of the many failures which had been registered against it in the East, capital was again found for its support.

Certain progress was made in San Francisco against the established companies, largely because the promoters were fortunate in being able to avail themselves of the increased efficiency of the incandescent burner as compared with the open tip burner, the former not having been introduced to any considerable extent by the older companies. With the ordinary observer, the Hall process, not the incandescent burner, obtained the credit of this economy. Thus there was a certain appearance of success, though as a fact not one of the extraordinary claims made for the Hall process could be verified from the San Francisco results. The quantities of materials used were far in excess of the claims, the quality of the gas was inferior, and the electrical action claimed for the "flower-pot" filling of the converters was non-existent.

This appearance of success in San Francisco was used to revivify the process in the East, and so successful was the promoter in impressing his points upon certain important men, that it was only after a long and determined fight that the truth was again made evident and the attempt to introduce the process into two or three cities on the Atlantic seaboard was defeated. Finally, as the result of hard, commercial experience the process was abandoned both here and in Oakland.

As part of my investigation, a gas similar to the Hall gas was produced by the continuous running of a regular, double superheater water gas apparatus, the fixing chambers being filled with firebrick in accordance with regular practice, thus disproving the claim of special virtue for the electrical flower-pot filling as used in the Hall process. Possibly we may be again troubled with the continuous process man, who will claim that his process transmutes the nitrogen resulting from the air blast into a combustible gas. In such a case, remember that with a

little practice you can with your regular water gas apparatus at least duplicate his actual results and thus prove that if his results are to be desired you have them at your command without his assistance.

HOW TO TREAT NEW GAS PROCESSES.

It is a remarkable fact that it is by processes of this character, wherein the element of the marvelous is included, that the uninstructed public can be the most easily deceived. The promoter suggests that a very small investment will bring in great returns, and, therefore, a small "flyer" is a fair speculation; that the gas experts are naturally opposed to him because his success means their loss; that every previous great advance in industrial science has been opposed by the experts of the day, and the steam engine, the telegraph, the telephone and gas itself are instanced.

The promoter's cause is almost always helped along by the ill-advised endorsement or partial endorsement of school men who have the name of being fair and scientific, but who in reality are not qualified to make a complete examination or to give a conclusive opinion. The partial certificate already alluded to, is a most dangerous element in the situation. Again, the promoter can usually obtain the more or less complete endorsement of some man well known in the gas world and believed by many to be a practical, able and honest gas engineer. Sometimes this endorsement is obtained by the payment of a "professional" fee, and sometimes it is the enthusiasm and lack of self-control of the engineer which hurries him into a position from which later he would gladly recede. We can all call to mind instances under this last head.

I have such an instance in mind, where an engineer, well known, and to some favorably known, reported in favor of a certain much advertised process, and in doing so made it the occasion for pointing out that his analyses of the gases distributed in a number of our cities demonstrated that the gas engineers generally had been deceiving themselves as to the true composition of these gases. This report was by some taken seriously and produced alarm. It finally developed that the methods of chemical analysis from which these revolutionary results were obtained were absolutely incorrect and valueless. This points the lesson that while we should investigate with an open mind, if we obtain results which completely contradict the results for years obtained by the great body of our fellow workers, we should incline to the belief that this failure to agree is the result of some error of our own.

There is another point which calls for special comment. Frequently when a new process is first bulletined, not only the public is deceived but also a considerable part of the gas fraternity, and this perhaps because the process seems to be making favor with the public and with the state and municipal governments. Battles are fought over the process, hearings are had before councils, papers are read before gas associations, discussions are carried on in the gas journals, and, finally, if the process is unable to maintain itself in practical competition, the collapse comes. Then the whole matter is apparently forgotten and peace again reigns. But the promoter again appears in the field with the same process or its equivalent, and now we find the public again deceived and gas men again in doubt and alarmed. We seem to get but little profection from our experiences. In my opinion this is because there is too little real investigation, and we are, therefore, quickly moved by gossip and current opinion. We do not, as we should, get down to the consideration of principles. On the other hand, even a process without merit should not be despised by the established companies, for not infrequently such a process, for which radical claims are made as to novelty and economy, secures a footing not obtainable by a process for which less is claimed but from which more can be obtained. Under the commercial test of competition the faulty process must be amended or actually discarded, but in the meantime a position more or less secure has perhaps been established by the new comer.

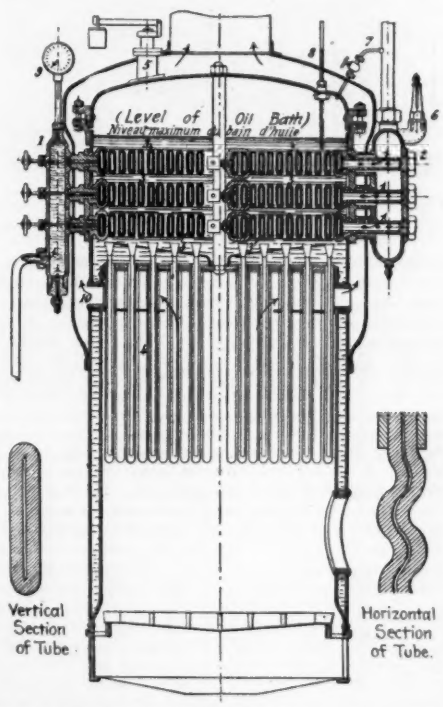
The best security against such attacks, although unfortunately this is not always sufficient, is to share with our customers the economies to be derived from an intelligent efficient, up-to-date management. Let me suggest to the younger members of the profession that when a process question is before them for solution certain simple steps may well be followed:

1. Obtain a definite statement of claims, covering results, apparatus and methods.
2. If it is claimed that from a given amount of gas making material a gas product can be obtained which will develop a greater number of heat units than the material itself contains, reject the claims.
3. From a preliminary examination of the claims and the surrounding conditions, decide whether or no an investigation is advisable.
4. If you decide in the affirmative, prepare to do your work guardedly, but with an open mind.
5. Accept no statements unless vouched for by some one known to you to be thoroughly competent and trustworthy. If possible, even then check up for yourself.
6. Before finally deciding to accept or endorse the process, make a working test, being careful to see that all conditions are such as can be obtained in practice. Measure all materials used and measure and value the product. Be sure all apparatus used for such measurements is carefully standardized, and take nothing for granted as to the course of the gas, the connections to the photometer, and the like. In other words, be sure that the gas you measure and value is the gas produced from the materials you have measured.
7. If commercial figures are quoted in support of the claims do not accept them without a critical expert examination of the books. Remember that it is not difficult to so keep books of account as to hide the truth.
8. Remember that an investigation and report afford quite as much opportunity for the exercise of common sense as of technical skill. If there are any modifying or qualifying conditions especially to be borne in mind in considering your report, draw specific attention to them either in your summary or your letter of enclosure.
9. Remember, if you make a report, you are responsible for its findings. Express no definite opinion unless you are fully satisfied with the thoroughness of your investigation. An incorrect opinion either for or against the process must work an injury.
10. Let no considerations of personal gain influence your judgment. Remember, there are refined and insidious methods of presenting such corrupting arguments.

A STEAM BOILER FOR VERY HIGH PRESSURES.

At the International Congress of Applied Mechanics held at Paris last July, M. Mahl described a new type of steam boiler, which had been constructed by himself and M. Nittis for the purpose of obtaining steam at very high pressures. The boiler is described in "Le Genie Civil" of August 18, from which we reproduce the accompanying illustration and abstract the following description.

In designing the boiler it was sought to so arrange the parts that those subjected to the high pressures should not be exposed to the fire. This



Vertical Section of Steam Boiler for Very High Pressures.

1. Water injection chamber.
2. Steam chamber.
3. Serpentine vaporizing tubes.
4. Oil heating tubes.
5. Safety valve of the oil chamber, set at 14 lbs.
6. Steam safety valve, set at 2,800 lbs.
7. Valve for maintaining the steam pressure of 14 lbs. on the oil.
8. Thermometer.
9. Manometer for 2,800 lbs.
10. Smoke flues.

was accomplished by a novel device. The heat is first transferred from the fire to a bath of oil, which in turn supplies heat to the tubes in which the steam is generated. The oil employed does not boil until a temperature of about 752° F. is reached, and does not give off inflammable vapors below 500° F. By carrying a pressure on the oil of about one atmosphere the temperature may easily be raised above 900° F.

Animal or vegetable oils would corrode the heating surfaces, but with a pure mineral oil no action of this sort is to be feared. Shut away from the air and prevented from forming vapors the oil undergoes no alteration and the heating surfaces remain perfectly clean.

In the figure is shown a boiler designed to work at a pressure of 2,800 lbs. per sq. in. The oil bath is contained in a vertical boiler of the Field type. The pressure in this vessel is maintained at about 14 lbs. gage by admitting a little steam and in this way the vaporization of the oil is prevented even at temperatures above 900° F. The curved or serpentine tubes in which the steam is formed are very thick and the distance of the walls apart is only .04-in. The water is injected at one end of the tube and the steam leaves at the other, as in the Serpollet type of boiler.

"Le Genie Civil" also illustrates and describes a boiler intended to carry ordinary steam pressures, in which this principle of heating by the medium of an oil bath has been used. It is a water-tube boiler resembling the Babcock & Wilcox type, but the water-tubes nearest the fire are replaced by tubes containing oil which communicate with other tubes within the water and steam drum. The circulation of the oil being established, heat is carried from the fire to the water in the drum, and the tubes containing water under pressure are not exposed to the hot gases when they first leave the fuel bed.

We illustrate this device and translate the above description merely as an engineering curiosity. Such a complicated contrivance for generating steam could offer, it would seem, nothing in the way of commercial advantage. The principle involved, however, is an interesting one, and one which may yet be applied for some purpose or other with practical success. A similar method of heat transmission was proposed by the late A. M. Wellington for use in his series engine, and considerable experiments upon heat transmission by this system were carried out by him. One of the most promising applications of this principle is to the superheating of steam and its reheating between the cylinders of multiple-cylinder engines. This application has, in fact, been patented in Great Britain by an English engineer.

It is possible that for water grates and similar parts of steam boilers, where trouble is usually experienced from the rapid collection of scale, an oil circulating system could be used to advantage. On the other hand, it must be remembered that some sort of pump must be provided to circulate the oil, that any leakage might cause danger from fire, and that the permanence of the oil under excessive heat is far from certain, notwithstanding the extravagant claims of the French inventors quoted above.

RECONSTRUCTING THE DEFECTIVE FOUNDATIONS OF THE HOTEL WOLLATON, BROOKLINE, MASS.

An interesting example of foundation reconstruction has been undertaken in connection with the Hotel Wollaton, at Brookline, Mass., which was condemned some two years ago by the authorities as unsafe. The building is a six-story apartment hotel situated on the north side of the Beacon St. boulevard, in Brookline, about ¼-mile beyond the Boston city line. It was built in the latter part of 1887, of a light-colored brick with stone trimmings, and was a very neat-looking structure. It was occupied by one or two tenants for a few weeks only. The following description of the defective foundation and its probable cause and of the proposed method of repairing it, have been furnished us by French & Bryant, of Boston Mass., the engineers for the work:

The site of the building was orginally low ground, slightly above high-tide level, although only fresh water entered through the narrow inlet from Charles River. The material in this vicinity is glacial drift, and rock is considerably more than 100 ft. below tide level. This was undoubtedly a "pot-hole," which was afterwards filled up by sediment and vegetation on which a cedar forest grew. Some action of nature, possibly the subsidence of floating surface vegetation, caused the trees to fall in all directions. Over these was deposited additional peat to the original high-tide level. Filling had been placed on this, compacting it to a certain extent.

Such circumstances necessitated the use of piles which were driven, according to various testimony, to depths of from 15 to 25 ft. below high tide. Some of these piles drove very hard through the surface filling, but the majority probably brought up on the trees and stumps in the peat. The building was erected on the piles, and during

construction, some of the walls settled considerably. Where the filling was the deepest, the settlement was comparatively small, but in the rear portion, it was considerable. When the masonry was nearly complete, certain walls were raised and the foundations strengthened by the use of iron beams and a grillage of hard pine timbers. The iron beams rested at one end on piles driven well outside of the building to a depth of 40 ft.

Notwithstanding these efforts to assist the original piles, the building continued to settle unevenly, a considerable section of the walls and the elevator wells being fully 1½ ins. below their original position. The iron beams which were used have twisted and bent, and some of them may have ruptured. After being condemned by the authorities as unsafe, the building was freed from its tenants, and for sometime the matter rested in the hands of the courts. The title to the property was finally secured, however, by Messrs. Charles and Cheever Newhall, of the Tremont Building, Boston, and now stands in the name of Charles A. Newhall. Much difficulty was experienced in obtaining this title, on account of the large number of liens, mortgages, etc., which existed. On completing the transaction, the Messrs. Newhall employed French & Bryant, Civil Engineers, of Boston and Brookline, to study the matter and devise some means for placing the building on a secure foundation.

It was desirable that this work should be done by contract, and for this reason, plans and specifications had to be provided, which should be subject to as little change as possible during the operation of the work. Prices were first asked for from contractors for moving the building one-half its width to one side, and placing and driving new piles on the other half, and also on the adjoining land, which is a part of the property. The building would have then been moved onto its completed foundations and properly underpinned, its final location being some 50 ft. west of its present one. This scheme was abandoned, partly on account of expense and partly on account of the difficulty of keeping the building sound during its movement over the soft soil about the building. Contractors were very loath to give a close figure on this work on account of the many uncertainties which existed. Plans and specifications were accordingly made for the construction of foundations with the building remaining in its present position, and figures were obtained on these plans. As the result, Messrs. Isaac Blair & Co., of Boston, moving contractors, signed the contract for the driving of the necessary piles; the lifting of the building to a level condition, and the placing of all iron work required. The balance of the work, such as earth excavation, concreting and masonry construction, together with the replacing of all plumbing and steam-fitting apparatus, will be done by the day as required.

After the building is finally supported in its permanent shape, the interior will all be done over. Any ceilings, floors, walls or wood work damaged in any way by the original settlement or by the contract work, will be renewed and the final result will be the making of the building not only absolutely sound and safe, but entirely fresh and new.

It is doubted if the building has ever been unsafe, even for the inmates thereof, but the authorities, to make matters doubly safe, fenced off a portion of Beacon St., to prevent any one being injured by falling walls. The building walls have now been tied together by strong rods and beams, so that there will be absolutely no danger during the raising of the structure.

Fig. 1.—Carriage and Skip of the Brothers' Electric Traveling Crane.

The plan finally adopted for supporting the building is to drive 40-ft. spruce piles around the exterior walls as close as possible to them. These piles will be driven by a hammer which is unique in Boston practice. It is a Warrington hammer made by the Vulcan Iron Works, of Chicago, Ill., and consists of a frame supporting a steam cylinder, to the piston of which is attached a heavy cast-iron ram. This whole apparatus takes the place of a heavy iron ram which is raised and lowered in the ordinary machine. This rests directly upon the pile tops, and when the steam is turned on, the ram is automatically raised and lowered a distance of about 30 ins., striking the pile from 60 to 80 blows per minute. These blows are relatively light, but are continuous, and on account of the reaction of the frame, are practically doubled. This does not allow the pile to rest or the material to settle about it. In this way, the pile is sunk with comparative quiet and a minimum jar to the ground.

The interior piles are to be driven to a depth of 50 ft. below the cellar bottom and will consist of three pieces of 10 × 10-in. hard pine, spliced by the use of long heavy iron bands or sleeves 24 ins. long. These piles will be driven in much the same manner as the outer piles, but it will be necessary to cut holes through the first floor to obtain the proper headroom. These interior piles number about 100, and will be driven very hard and heavily loaded.

After the piles are in place, they will be capped by iron beams and concrete, and cross-capped under the walls by heavy iron beams, also surrounded by concrete. When these beams are in place, the building will be temporarily supported on the new foundations until the masonry can be built up to the bottom of the old. It is expected that this work will be completed by Jan. 1, and while the engineers expect to meet with some considerable difficulties in carrying out this scheme, it is hoped that the building will be ready for occupancy by Feb., 1901.

A CABLEWAY HOISTING AND CONVEYING APPARATUS WITH TRAVELING ELECTRIC MOTOR.

The cableway illustrated in the accompanying cuts is in operation on Section No. 11 of the Rapid Transit Ry. tunnel in New York city at Broadway and 114th St. Mr. John Shields has the contract for this section and has installed this machine on trial near 114th St. to hoist skips from the trench and carry them along the line to a point where they can be dumped into wagons. It will be seen that the machine accomplishes the same work as the well-known trench machines, but requires no trestle or other structure in the street, except the shear legs which support the cable at each end.

Cableways, it is true, have been used before for trench excavation, but they have been operated by a hoisting engine at one end. The chief novelty of the machine here illustrated is that it is operated by electricity, and the electric motor is mounted directly on the traveling carriage. The operator rides on the carriage and controls the operations of hoisting, conveying, dumping and lowering by a system of switches. Thus one man does the work which requires two or more men in other types of trench machines. An additional important advantage is that the operator is located close to the skip which is being moved, and he can direct its movements much more easily than when he is located some distance away, as is the engineman operating the common steam trench machines.

The electric motor which performs the work of hoisting and conveying on the carriage is of 15 HP. capacity and is provided with the usual switches, rheostats and other controlling devices. A reversing switch enables it to drive the carriage in either direction.

Upon the end of the motor shaft is mounted a

FIG. 2.—MANNER OF DUMPING THE SKIP.

FIG. 3.—ONE OF THE A-FRAMES AND THE ANCHORING WEIGHT, THE LATTER RAISED FROM THE GROUND.

friction pulley which may be caused to engage and drive either of the two large wood-rimmed pulleys to be seen upon the farther side of the carriage in Fig. 1. The shaft of the upper large pulley carries a pinion which engages with teeth on the periphery of the two traveling wheels. The lower wood-rimmed pulley operates by worm-gearing the drums upon which are wound the cables from which the skip is suspended. These drums may be worked independently, and in that way the skip may be dumped (see Fig. 2). The

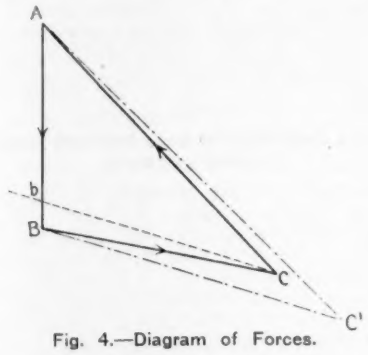


Fig. 4.—Diagram of Forces.

motor can hoist and carry a skip load of about three tons. The current is led to the motor by a small trolley wire strung below the main cable and which may be seen passing over the two small wheels at the side of the carriage. The main cable carries the return current. The main cable would usually be grounded, but in the present installation a 220-volt direct current is being taken from the outers of the Edison three-wire system. This necessitates strain insulators in the hoisting ropes leading to the skip, which in the present instance are short pieces of manila rope.

One of the unique features of this cableway is the manner in which the main cable is supported. It is fixed at either end to an inclined A-frame which is free to swing up and down and is loaded by a weight hanging at its outer end. The cables supporting the weights on the A-frames are of such a length that both weights cannot rest upon the ground at the same time. The proper magnitude of these weights is known from the deflection of the main cable when the latter is hanging freely.

When the carriage travels away from one of the shears the main cable sags and the weight at that end rises (see Fig. 3), but when the carriage returns the change in the inclination of the main cable at the point where it is attached to the shear is sufficient to give the weight a preponderance and it sinks.

This may be understood from the triangle of forces in Fig. 4. Let A B be the force exerted by the weight hanging vertically; it is constant in magnitude and direction. B C will be the tension in the main cable and C A the thrust in the A-frame. If the inclination of B C now changes to b C, A B will be greater than the resultant of b C and C A and will pull the end of the A-frame down until a new position of equilibrium is reached, as indicated by the triangle B C A. The work done by the falling weight is expended in lifting the load on the carriage, so that the motor is assisted a certain amount as it approaches the A-frame. And also on account of the automatic lowering of the latter there is less total work to do.

An important advantage of this arrangement is that the skip may be brought out beyond the point of support of the A-frame, as will be seen in Fig. 2. Another advantage is that the A-frame may be mounted upon wheels. If one is so mounted and the other end of the cable is fixed, the frame may be made to travel about on a circular track having the center of curvature at the fixed support. In this way a large area may be covered. In a similar manner both frames may be mounted upon wheels running upon parallel tracks.

The machine above described was invented and is being placed upon the market by Mr. W. F. Brothers, Singer Building, New York city.

THE PROPOSED SEPTIC TANK AND SEWAGE PURIFICATION STUDIES AT WASHINGTON UNIVERSITY.

An attempt to throw additional light on some of the problems of sewage purification is proposed at Washington University, St. Louis, Mo., in connection with a new septic tank. The subject was presented to the board of directors, a few weeks ago, by Prof. J. L. Van Ornum, who first reviewed the development of the septic process, in practice and in theory, and then discussed the problems needing further study and how such investigations might be made in connection with the proposed tank. Professor Van Ornum stated that although the five years during which the septic tank has been studied is too short a time to investigate each step of the process and all the attendant phenomena in detail, yet the system has been so thoroughly tried and proved that it is now beyond the experimental stage, and is a success. In smaller towns and large institutions where it has been installed it not only is efficient, but as an economical agent it is unrivaled because of the small area it occupies, its speedy action and its operation with almost no attention. It may be expected that as the application of established principles are perfected and further investigations are made, its efficiency will become still greater and its field of application be extended.

In partial support of the statement just quoted the accompanying table was presented, giving particulars relating to 17 different installations. The concluding portion of Professor Van Ornum's report, relating to the problems involved and the possibilities of studying them at Washington University is given in full below:

The complete purification of sewage (from water-borne organic wastes to final, stable, harmless compounds) consists of three distinct stages: (1) Dissolution of the suspended matter; (2) carbon-oxidation, and, (3) nitrogen-oxidation. It seems decidedly advantageous to have the first stage (liquefaction) completed before the last two (fermentation) are entered upon. The very extensive and valuable researches of Adeney (1896) show that the second stage (bacteriolysis) must be completed before the third (nitrification) will occur; that the significant product of bacteriolysis is ammonia (ammonium compounds), while water and carbonic acid, with relatively small quantities of organic matter in a much altered form, are also produced; that the carbon dioxide formed and the oxygen consumed, at the completion of bacteriolysis (in the presence of oxgyen) are directly proportional to the amount of polluting matter originally present; that the significant product of nitrification is nitric acid (nitrates), and the intermediate form of nitrites, while water and small quantities of carbonic acid are formed; that for thorough fermentation it takes the oxygen of about three volumes of air to one volume of sewage, half this for bacteriolysis and half for nitrification; that after the second stage is complete, offensiveness cannot result because even without the oxygen necessary for nitrification the final process is merely suspended, the possibility of putrefaction no longer existing; that for bacteriolysis (in the presence of oxygen) the time necessary is "considerably less than 12 hours"; that the time necessary for nitrification is relatively considerable; that if oxygen is not available for bacteriolysis this second stage becomes a process of putrefaction, with the characteristic production of foul-smelling gases.

It should be noted that the nitrification of the sewage is, then, necessarily provided for only when, in its future flow, it is liable to be used as a potable water; that for this stage oxygen is absolutely necessary, whether or not it has been supplied to the sewage during the two preceding stages; that a temperature between 50 and 100° F. best promotes bacterial activities; that antiseptics and acids should be rigidly excluded; that chemical wastes often require especial treatment; and that if virtual purification (a freezing from forms of organic matter that are capable of developing offensive products in the future flow) is all that is required, it is necessary to carry the process only to the beginning of the nitrification stage. This would seem to be the especial province of the septic tank, as seen from the details of septic action already given. It will be noticed, concerning the process of bacteriolysis, that Adeney considers oxygen to be essential; but as anaerobic action also produces the characteristic ammonium component of the effluent, it would seem that perhaps the septic tank may prepare the effluent for nitrification equally thoroughly, with the economic advantages already mentioned in its favor, and others to be mentioned later. In fact Rideal (1899) claims that this is already shown to be true. He says: "It is a mistake in the first stages to introduce air, which merely hinders the anaerobic changes." He also strongly advocates dividing the process of purification into three stages, of which the first he calls "Anaerobic liquefaction and preparation by hydrolysis," producing "Soluble nitrogenous compounds, fatty acids, phenol derivatives, gases and ammonia;" the second, "Semi-anaerobic breaking down of the intermediate dissolved bodies," producing "ammonia, nitrites and gases;" and, the third stage he defines as "Complete aeration, nitrification," producing "Carbonic acid, water and nitrates." This question of anaerobic bacteriolysis needs further study, and may prove to be the vital one.

Whether or not the structure of the septic tank excludes the air, the mat of scum that forms practically has that effect, necessarily resulting mainly in anaerobic action; tests of Manchester effluents by Fowler proves this to be the case. For the liquefaction of suspended matter considerations of economy and efficiency both commend anaerobic conditions. Dr. Griffiths recently said "Liquefaction requires no oxygen, and is actually hindered by it." A third advantage also seems probable, though not yet proved; that is, that disease-producing germs cannot survive the anaerobic process. To test this Dr. Pickard experimentally introduced the typhoid bacillus in large numbers at the Exeter septic tank, and during a 40-hour stay, 96% were destroyed, and during a 24-hour stay, 70%. It would mean much if further experiment should prove that pathogenic bacteria are destroyed under conditions where oxygen is wanting.

For the reasons given the absence of air during the liquefying stage seems desirable; if it should be found on further experiment, as some results already seem to indicate, that a complete bacteriolysis will not occur in the septic tank as at present used, oxygen may be supplied in a second chamber to perfect this action either by introducing oxygen-yielding chemicals as successfully applied by Parry at Dundrum Asylum, Ireland, in the form of manganate and nitrate of soda (though this adds to the complication of the resulting sludge-disposal), or perhaps better by injecting filaments of air under pressure, something as Waring did in gravel beds at Providence (Newport.—Ed.) five years ago, resulting (without a previous liquefaction) in a removal of 92% of the organic nitrogenous matter.

Information Relating to Seventeen Septic Tank Installations in Great Britain, Ireland and America.

No.	Location	Date of construction.	Area, ft.	Depth, ft.	Capacity, galls.	Population served.	Hours in passing through.	Kind.	Frequency of sludge removal, mos.	Percentage of reduction of organic matter in— Suspension.	Solution.	Odor.	Remarks.
1.	Exeter, England	1896.	65 x 18	7 +	65,000	15,000	24	Closed.	36	55	31	Practically none.	
2.	Yeovil, England	1896.	.....	..	21,000	....	24	Closed.	36	..	..	Practically none.	
3.	Champaign, Ill.	1897.	37 x 16	5	22,000	3,500	1	Open.	4	94	17	Little.	
4.	Sutton, England	1897.	1,647 sq.ft.	3½	.....	....	..	Open.	..	95	..	.....	Experimental.
5.	Leeds, England	...	.....	..	.....	....	..	1 clsd; 1 opn	12	..	..	Some.	Experimental.
6.	Manchester, England	1898.	40 x 12	9 +	.....	....	..	Open.	12	..	..	Some.	"
7.	Lawrence, Mass.	1898.	.....	..	.....	....	30	Closed.	..	50	..	Pronounced.	"
8.	Wolverhampton, England	...	.....	..	.....	....	..	.....	..	..	..	.....	
9.	Owestry, England.	1898.	.....	4½	.....	10,000	..	Open.	..	..	..	.....	
10.	Ames, Ia.	1898.	56 x 22	4	40,000	600	6	Open.	..	..	..	Some.	
11.	Verona, N. J.	1898.	50 x 18	10	65,000	300	40	Closed.	12	..	..	Considerable.	
12.	Portadown, Ireland	...	.....	..	22,000	3,000	..	.....	12	..	..	Some.	
13.	Accrington, England	1898.	.....	.	.....	....	..	.....	..	..	..	Some.	
14.	Huddlesfield, England	...	.....	..	.....	....	..	.....	..	..	..	Slight.	
15.	Barrhead, Scotland	1899.	100 x 18	7	400,000	10,000	24	Closed.	..	..	..	.....	Four tanks.
16.	Independence, Mo.	1899.	.....	..	....	....	..	.....	..	..	..	.....	
17.	Marion, Ia.	1899.	.....	..	.....	....	..	.....	..	..	..	.....	

*Three tanks, filled with coarse burnt ballast.

The especial field for further experiment, to secure both increased efficiency and wider application, is in this second stage; though the time necessary for effective hydrolysis and the exact nature of the compounds which result, the question of whether liquefaction and bacteriolysis must or may not be strictly distinct and separate processes, the question whether or not nitrifying bacteria thrive better in darkness, the possible field and treatment of enzymes in the process, so as to secure their most effective aid in breaking down the organic matter, and the corroboration of the necessity for complete bacteriolysis to prevent the possibility of offense either in running water or in air, are some of the questions which are most pertinent in making thoroughly practicable the virtual purification of sewage—a question that is of especial moment both because it is less thoroughly understood than the subsequent nitrification effecting ultimate purification, and because it covers the range of works that embraces the majority of cases where sewage purification will be required in this country.

The floating mass of scum that forms on the surface of the sewage in the septic tank is usually several inches thick; is a tenacious, flocculent, brownish material, taking generally several weeks to form, and seems to be the especial seat of bacteriological action; in fact, its condition may be considered an index of the thoroughness of the process. It has been frequently noticed that as activities increase in this floating mass, the amount of sludge decreases.

The residue of sludge that collects at the bottom varies materially under different circumstances, as may be seen in the table given before; and its occasional removal has been the main expense of operation of the septic tank. Under thoroughly efficient action its amount should be very small, in fact it should consist only of the insoluble mineral matter that may be introduced.

The first septic tanks were carefully covered by tight roofs to insure anaerobic action, but results of experiment at Manchester, Leeds, Lawrence and other places show practically the same effluent where no cover was used. The question between the closed and open tank then (except in climates where freezing winter weather would prevent the efficient action in an open tank) reduces itself merely to the desirability of controlling the gases that form during the process. This control should concern itself mainly with the liability of danger of a nuisance from offensive odors. As seen in the table, the odors are stated to range from "practically none," at the Exeter plant, to "considerable," at the Verona works. It may be safely said that, in the usual case, the offensive odors in the immediate vicinity are slight, and where the works are at some distance from residences no offense can occur. There is always, however, whenever the septic tank is near buildings, the opportunity to control the gases by covering the tank and either discharge them through stacks high above the ground where the gases will be dissipated in the upper air, or to burn them as was done at Exeter, where "the flame is odorless, almost without color, and the gas before burning has only a slight musty smell." This burning would not only prevent the possibility of unpleasant odors, but would also insure the harmlessness of the gases that mingle with the atmosphere.

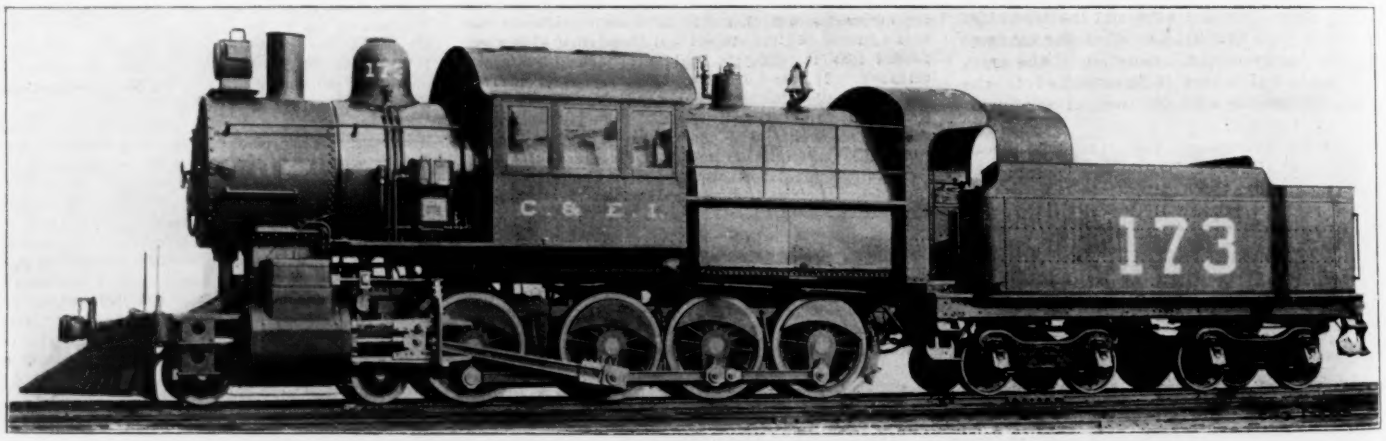
The Washington University septic tank is intended to have a manhole grit-chamber so arranged that mineral sediment can be flushed through the by-pass around the tank, or be removed at the surface. The septic tank proper is designed to dispose of the sewage of 2,000 persons from a "separate" system of sewers, opportunity being given to vary the number of hours consumed in passing through the septic tank (to suit variations in experimental tests and in the duty of service) by regulating the depth of the sewage standing in the tank. It is to have three chambers; the first for anaerobic action, where the impurities in suspension will become liquefied, and having a capacity of about 5,000 cu. ft.; the second chamber is intended for the second stage of purification, as before discussed, and will be the especial field of experimental investigation, and should be fitted with facilities to thoroughly promote either annerobic or aerobic action as may be found to be the more efficient in completing the process of bacteriolysis; it should therefore have facilities for ready ingress to effect changes in its equipment that may develop, should have a system of pipes for blowing air through the liquid, and other details for developing the most thorough and economical method of effecting this last stage of virtual purification; its capacity should be about 4,000 cu. ft.; the third chamber is intended primarily for the storage of the effluent so that it may be periodically discharged in a few moments when full and so flow away in a considerable body, though it will serve at the same time to prove the thoroughness of the previous virtual purification and may be of further use in connection with the study of nitrification; its capacity should be about 1,000 cu. ft. All the chambers should have facilities for the occasional cleaning out of sediment, and should have an air-tight covering to prevent the escape of all gases and to permit a thorough control of the conditions affecting the successive processes of purification; and each chamber should have a high vent-pipe, with a burner inside for the combustion of the gases formed. There is also to be opportunity for thoroughly controlling the process and the securing of samples for chemical and bacteriological analysis; for, while the main purposes of this septic tank is to so purify the sewage that the effluent will cause no offense either at the Washington University grounds or in its subsequent flow, at the same time it should also serve as an experimental plant to aid in perfecting the operation of septic tanks and to assist in the further elucidation of the principles affecting the virtual purification of sewage.

TWELVE-WHEEL COMPOUND FREIGHT LOCOMOTIVE; CHICAGO & EASTERN ILLINOIS R. R.

We illustrate in the accompanying cut a twelve-wheel compound freight locomotive recently completed by the Pittsburg Locomotive Works for the Chicago & Eastern Illinois R. R. The principal dimensions and details of this engine are given below in our standard form:

Dimensions of 12-Wheel Compound Freight Locomotive; Chicago & Eastern Illinois R. R.

Running Gear: Driving wheels (8), diameter	4 ft. 6 ins.
Truck wheels (4), diameter	2 " 4 "
Tender wheels (8), diameter	2 " 9 "
Driving wheel centers	Cast steel.
Journals, driving axles	8½ × 10 ins.
Journals, truck axles	5½ × 10 "
Wheelbase: Driving	15 ft. 6 "
Total engine	26 " 4 "
Engine and tender	51 " 2 "
Cylinders: Number	Two.
Diameter and stroke—h. p.	21½ × 30 ins.
Diameter and stroke—l. p.	33 × 30 "
Weight in Working Order:	
On driving wheels	150,000 lbs.
On truck wheels	39,700 "
Engine, total	189,700 "
Tender, loaded	98,000 "
Water in tank	4,500 galls.
Coal capacity	20,000 lbs.
Valve Gear: Type	Link motion.
Ports, steam—h. p.	18x1⅞ ins.; l. p. 21x2 ins.
Exhaust— "	18x3 " ; " 21x3½ "
Bridge width	1⅜ "
Slide valves, style	Balanced.
" " max travel—h. p.	5 ins.; l. p. 6 ins.
" " lap, inside	⅜-in.; outside 1-in.
" " lead in full gear	1/16-in.
Boiler: Type	Wooten extended wagon-top.
Barrel, diameter at front ring	6 ft.
Dome, diameter	2 ft. 8 ins.
Thickness, barrel plates	11/16-in. and ¾-in.
Thickness, tube sheets ½-in.; crown sheets	7/16-in.
Horizontal seams	Sextuple riveted.
Circumferential seams	Lapped; double riveted.
Height from rail to center line	9 ft. [illegible] ins.
Smokebox, length 5 ft.; diameter	[illegible] 1 in.
Working steam pressure	[illegible] lbs.
Firebox: Type	[illegible] Wooten.
Length 9 ft.; width	8 ft.
Depth: Front 5 ft. 11⅝ ins.; back 4 ft.	[illegible] ins.
Material	Steel.
Crown stays Radial; Grate bars	[illegible] Rocking.
Water space: Front, 4 ins.; back, 3½ ins.; side	[illegible] ins.
Tubes Charcoal iron; No.	[illegible] 300
Diameter, outside	[illegible] ins.
Length over tube plates	14 ft. [illegible] ins.
Heating surface and Grate Area:	
Heating surface, tubes	2,265 [illegible] sq. ft.
" " firebox	181 [illegible] "
" " total	2,447 [illegible] "
Grate area	72 "
Miscellaneous:	
Exhaust nozzle (single), diameter	4½, 4¾ and [illegible] ins.
Distance, top above center of boiler	[illegible] "
Smokestack (straight), diameter	16½ "
Height above smokebox	2 ft. [illegible] ins.
Brake fittings	New York Air Brake.



TWELVE-WHEEL COMPOUND FREIGHT LOCOMOTIVE FOR THE CHICAGO & EASTERN ILLINOIS R. R.
Pittsburg Locomotive Works, Pittsburg, Pa., Builders.

THE FALK CAST-WELDED RAIL JOINT ON EUROPEAN STREET RAILWAYS.

Among the reports presented at the International Tramway (Street Railway) Congress, held at Paris in September, was one on the use of the Falk cast-welded joint, by Mr. Fischer Dick, of the Great Tramway Co., of Berlin. Since 1896 there have been made 2,600 joints at Paris, 3,400 at Nice, 1,700 at Lyons, 1,200 at Rouen, 6,500 at Havre, 6,000 at Marseilles and 7,600 at Berlin. The cost per joint (exclusive of royalty, interest and paving) is given as $4.02 at Lyons, $3.30 at Marseilles and $3.12 at Havre (or $4.06 at Havre if the royalty and interest are included). At Berlin, the cost is $4 or $5, including the paving. At Havre, 100 joints per night have been made with 30 molds and 60 clamps. At Berlin the cost of metal for 50 joints was $80. In this city no expansion splice joints are used, but the French General Tramways Co. (which owns lines in several cities) uses these splice joints at intervals of 820 ft. Breakages have been 1.25% at Berlin, 0.5% at Lyons, 0.4% at Marseilles, 4 in 3,800 joints at Havre and 2 in 2,600 joints at Paris. Parting at the joints is attributed to lack of care in cleaning and fitting the ends of the rails. Cracks in the rails are caused by the contraction of the rails after the joint is made, which contraction is increased in winter. At Berlin, only one fracture occurred in asphalt paved streets. At Lyons, Paris, Nice and Berlin the use of the expensive copper bonds has been dispensed with, but these are still used at Havre, Marseilles and Rouen. Tests made of the conductivity of the joints at Marseilles showed varying results, according as the connections between the rail and cast block were more or less efficient. It is pointed out that the greatest care should be taken in the cleaning of the ends of the rails. In more recent applications of the system in France, the use of electrical bonds has been discontinued.

The information presented by the tramway companies which have tried this system show very forcibly its importance in regard to the solidity and stability of the joints. Old tracks which were not strong enough for electric traction have been in this way rendered serviceable for some years. For new tracks it suppresses

the noise due to the ordinary joints and gives a more permanent and economical track than any other form of joint. In Berlin, however, while it gave great stability to old rails with badly worn ends, it could not prevent the noise due to the passage of cars over these low spots, and for this reason certain sections of track were renewed after two years' service. This was notably the case with the Phoenix girder rails and miter joints, which offered special difficulties to the application of the cast joint. An interesting phenomenon is the contraction of the rails after the joints have been cast, for which no explanation has yet been given. The force of contraction is very great, and explains the fact that no expansion is observed on such track even under a hot sun. On new lines it is possible to reduce this contraction to a certain extent, but this is not possible in applying the joints to existing track. Mr. Dick has noticed that beyond fractures a further contraction is produced by changes of temperature, and he therefore recommends that such fractures should not be spliced in the usual way. At Berlin, the shims or templates of rails inserted at the breaks and secured by means of splice bars have had to be replaced in a little time with longer pieces because the lines of rails continued to contract.

An advantage of the cast joint over the electrically welded joint is that the former does not heat the head of the rail high enough to have a deteriorating influence upon the metal; only the flange and the lower part of the web receive the full heat of the molten iron. A disadvantage in regard to its general use is that it cannot be used for a small number of joints, 20 for instance, because the metal in the cupola is not then entirely utilized. At Berlin, the tracks are built at the same time that the city lays the pavement, and the progress is only about 8 to 10 rail lengths per day. The casting of joints is impossible under these conditions. The Falk joint has in great part delivered the tramway engineer from the incessant necessity of repairing the track to keep it in good condition owing to the destructive effects of the wheels, as the continuous rails are more durable and are capable of carrying heavier loads. Even the best splice joints will wear and cause the track to become rough at the joints, and its renewal on this account often becomes necessary when it is otherwise in good condition.

BROKEN AND SQUARE RAIL-JOINTS FOR RAILWAY TRACK.

In railway track, the rails may be laid with joints square (opposite one another) or broken; in the latter case the joints in one line of rails are opposite the middle of the rails on the other side. Both methods are followed, and there is considerable diversity of opinion as to their respective merits, but the latter method is by far the most generally followed, as was shown very clearly by the tables of standard track construction in our issue of Aug. 30, 1900. As this question is still a disputed one, however, and has been brought up by our correspondents at various times, we have made some inquiry as to the use of the two methods, and the reasons for and against them.

Square joints are used sometimes on new lines not fully ballasted, on account of the banks settling, it being claimed that the track rides easier, has less lateral motion and can be maintained better under these conditions. They are used mainly in the West, as with the comparatively light roadbed construction of many railways in that territory the track settles most at the joints. With broken joints, according to their opponents, the number of low places would be increased, and the weight of the train would be thrown laterally against low joints, tending to throw the track out of line. With square or even joints only the shock due to settlement will be experienced, and there will be less trouble in maintaining line and surface. On the other hand, square joints tend to form kinks in the track, and on many Western roads, with comparatively light track, it is considered that broken joints make easier riding track, less liable to get out of line and less expensive to maintain. With broken joints, the hammering effect which tends to cause low joints is better distributed over the track (particularly when it is well ballasted), and there is less difficulty in keeping up the joints. The cars also ride more smoothly, as occasionally low joints cause only a slight rocking of the car to one side, while low square joints would cause a more noticeable and objectionable pitching motion.

Tracklaying takes more time with square joints than with broken joints, as with the latter the joints can run some distance ahead of the middle of the opposite rail (on curves) before it becomes necessary to cut a rail. In fact, some roads using square joints on tangents use broken joints on curves. The opinions in favor of square joints above noted, are by no means generally held, even in the West, and the prevailing opinions are strongly in favor of broken joints for all kinds of track, as they make a better running track, hold the surface and line better, and require less maintenance work. This latter point is an important one on a road with light track and a limited track force.

We give below some expressions of opinion upon this question, which have been furnished to us by officials of several prominent railway companies:

ATCHISON, TOPEKA & SANTA FE RY.—The standard track consists of 75-lb. rails. (Am. Soc. C. E. section), spliced with 38-in. angle bars on three ties. The track is laid with broken joints on ballast and square joints on earth filling. The reasons given in favor of broken joints are that a car runs more smoothly on ballasted track when the joints are broken, as if a joint is a little low it only affects one side of the car. This causes only a slight rocking motion, whereas with even joints it would cause the car to pitch. It would seem, however, that low joints are much more likely to occur on track ballasted only with earth, in which case the objectionable pitching movement would be more severe than on track ballasted with a more stable material. This motion, however, produces less lateral strain upon the track.

BALTIMORE & OHIO R. R.—The track is laid with 85-lb. rails (Am. Soc. C. E., section), with broken suspended joints, spliced with the continuous joint device. The reason given for adopting broken joints is that they make a stronger and more substantial track.

CHICAGO & NORTHWESTERN RY.—The question of even or broken joints is an old one, and hard to settle. The greatest objection to even joints seems to be on double track. The joints being fastened to the ties, with the creeping of the rails that end of the two joint ties goes with the rail, and slews the ties so that they are not square across the track; this of course pulls the track out of gage and out of line. There is something in this, but by overcoming the creeping of rails, which has been done to some extent, this objection disappears. New tracks are built with square joints on account of the banks settling, and the claim is made that new track can be maintained better for that reason. The objection to square joints is that they become evident to the passenger as soon as a train strikes track laid with them, unless the track is kept up to a higher degree of excellence than is usual. It also takes more time to lay rails with square joints, and the rail ends batter more quickly than at broken joints.

CHICAGO GREAT WESTERN RY.—The track is laid with 60 and 75-lb. rails, with square suspended joints, spliced by 22 and 26-in. angle bars. The reason given for the adoption of square joints is that the roadbed is new and not fully ballasted, under which conditions these joints are considered to give a better riding track with less lateral motion.

DENVER & RIO GRANDE RY.—The standard track has 85-lb. rails, with square suspended joints, spliced by 26-in. angle bars. Broken joints are not adopted because, with the roadbed and ballast which is usually found in the West the track settles more at the joints than at other places. When a joint settles there is a tendency for the track to get out of line, as the weight of the train throws it toward the low joint. With broken joints there are more places where the track will thus move toward the low joint. Even joints are adopted because they reduce the number of places where track settles; the train in passing over even joints will receive a jolt due to the settlement, but it will not also receive one caused by the track being out of line. Without a firm roadbed and a large depth of good stone ballast a train will ride smoother where the track is laid with even joints.

LAKE SHORE & MICHIGAN SOUTHERN RY.—The rails are laid with broken and supported joints. This matter of broken and square joints has been pretty thoroughly threshed out, and under certain conditions each method has its advantages and disadvantages.

ILLINOIS CENTRAL R. R.—The track is laid with 83-lb. rails (Am. Soc. C. E. section), with square, three-tie joints, spliced by 40-in. angle bars. It is stated that there is less trouble in maintaining line and surface with the square joints than with broken joints.

LEHIGH VALLEY R. R.—The standard track is laid with 90-lb. rails (Am. Soc. C. E. section), with broken, suspended joints, spliced by 28-in. angle bars. The reason for favoring the broken joint is that as the joint is the weakest part of the track, and the hardest to keep up (due to the hammering of the moving load), it is not desirable to concentrate this entire hammering at practically one point of the track, as would be done with square joints. Where the joints are broken, it is much easier to keep joints in good surface, as the joint ties are not loosened up so quickly.

NORTHERN PACIFIC RY.—The standard track is laid with 72-lb. rails, with square, suspended joints, spliced by 24-in. angle bars. In 1892, Mr. McHenry, Chief Engineer, made special tests for the purpose of determining the relative merits of broken and square joints. A section nine miles in length between Tacoma and Puyallup was double-tracked. The old track was laid with 66-lb. rails with even joints, and the new track was laid with rails of the same section, but with broken joints. After several years' trial, one rail of the new track was taken up and was laid with square joints. It was found practically impossible to prevent ties from slewing, the joints carrying the ties ahead alternately on each side. The traffic on both tracks was substantially the same. There were no grades and but two or three curves in the section, and the test was a fair one in all respects. It is believed from the condition of track on eastern roads where broken joints are in use, that these roads experience the same difficulty as noted on the experimental section. This objection, however, may not obtain on single track sections with traffic in both directions.

WABASH R. R.—The standard track has 80-lb. rails laid with broken joints. Broken joints are used, as they make an easier riding track, which is less liable to get out of line and less expensive to maintain. It is considered that the rail joint question is an important one still, and that the proper joint device has not yet been invented.

A DEVICE FOR REGULATING the strength of the poles of an electric dynamo or motor has been invented by Professor Elihu Thompson and assigned by him to the General Electric Co. It is well known that one pole of a multipolar machine is often stronger than the others, in consequence of which the portion of the armature under that pole furnishes more than its share of the current. This has been remedied by so constructing the magnet frame that the magnetic reluctance of various parts of the circuit may be varied at will. In the present invention holes are drilled transversely to the line of magnetic flux. These are filled with cores of laminated iron. These may be turned so that the laminations are either parallel with or at right angles to the lines of force.

A DUPLEX TELEPHONE line has been established between the cities of Yokohama and Tokio in Japan. The government had installed two metallic-circuit lines between those cities, the capacity of which soon became inadequate for the service. In the absence of an appropriation for the establishment of a third line it was decided to duplex the existing lines. At each terminal a connection was made to the middle of the primary winding of the repeating coil of each line. The cross connecting line was fitted with the usual telephone instruments. Thus each leg of the new third line is double, consisting of the metallic circuit of one of the other original lines. There is said to be no cross-talk.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXI-XXIII. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

The award of contracts to American firms for engineering works in Egypt, South Africa and Uganda is stirring up a hornet's nest in England, and the responsible officials are roundly denounced for not giving preference to British manufacturers. One London newspaper satirically remarks: "The battles of El Teb, Tel-el-Kebir, Abu Klea, Atbara and Omdurman were fought, apparently, merely to open a new field for American trade," and refers indignantly to "the propensity of some Colonies to buy anywhere but in England."

On the other hand, the Government officers who are the subject of this criticism reply that they place contracts with American firms because they can obtain lower prices and more prompt delivery. It would be reversing the whole Colonial policy of England for the administrative officers to carry on Colonial business with the fostering of British trade as their main motive. On the contrary, the first duty of these officers is to their stockholders, in the case of a private company, or to the people of the colony in the case of a Governmental work. They have no right to place additional burdens upon the taxpayers, or sacrifice the income of the stockholders for the sake of helping British manufacturers. If the latter can offer as good terms as their rivals, they will naturally be preferred; but the idea that British Colonial possessions exist to be exploited for the benefit of the mother country was effectively settled by the American Revolution, and is not likely to be reinstated at the present day as a feature of British Governmental policy.

The fact of the matter is that American deposits of cheap coal and cheap iron ore, with the plants of enormous capacity and wonderful efficiency which have been constructed to utilize them can produce iron and steel at a cost so much below European figures that under normal conditions American exports of these materials are bound to increase. That Asia and Africa should come here instead of going to Europe, for bridges and rails and rolling stock and heavy machinery and other lines of manufacture in which iron and steel are the chief raw material, is only a natural result of trade conditions.

Apropos of American iron and steel producers, however, it is worth noting here that the very recent movement for the formation of pools and the fixing of exorbitant prices upon pool products is a matter that deserves even fuller publicity and more vigorous comment than it has received. We have recently noted the fixing of a pool price of $26 per ton for steel rails. This has now been followed by the formation of a pool among the 14 steel-plate producers which has fixed the price of plates at $27 per ton at Pittsburg, and pools on steel billets, structural shapes, beams, bars, and other standard products are announced as in process of formation.

There is nothing surprising in the formation of these combines. It has long ago been shown that the chances of effective combinations being formed always increase as the number of competitors is reduced. The idea that the combinations which have taken place in the iron and steel trade would stimulate competition has been well advertised; but it does not conform to well-known facts or the conditions of human nature. On the contrary, it appears to be almost if not quite as necessary for a half-dozen competing rail mills to agree upon a price for rails as for competing railway companies to agree upon uniform rates of fare and freight. But the steel rail mills, like the railways, have duties toward the public. An exorbitant price cannot be justified in the one case more than in the other. To raise the price of iron and steel products to an excessive figure must result in checking consumption, limiting business expansion, and blocking the wheels of prosperity. Such action may raise the prices of certain "Industrials" in the speculative stock market and replenish the treasuries of concerns whose financial operations are a sealed book even to their own stockholders. It may even result in the payment of dividends on stocks which represent nothing but wind. None of these things, however, are likely to be accepted by the public as valid excuses, and the outcome is likely to be salutary restrictive legislation. The policy of granting reducing prices to the foreign purchaser while maintaining pool rates to the home consumer is a policy which no party will defend, and one which Congress is pretty certain to effectively rebuke at the first opportunity.

It would be a great pity if the subways, or pipe galleries, until recently under construction by the New York Rapid Transit Commission, in Elm St., should be abandoned, nor do we believe such action will be the outcome of the protests just made by the water and sewer departments of the city. As we understand it, the two departments just named do not oppose the subway galleries, but are in favor of them, provided their size is ample and that the water mains and sewers placed therein are readily accessible for all necessary purposes. The departments claim that the subways, as planned, lack both capacity and accessibility, and that they have never been consulted as to their design. It seems, therefore, as though an agreement might be reached under which the subway galleries may be completed. The work in hand is similar in its general plan to that carried out at St. Helens, England, during a reconstruction of street railway track on a busy thoroughfare (see Eng. News, March 15, 1900, for description of this and other subways in English cities). The proposed New York subway has been looked upon by engineers and others as a great object lesson to all who are responsible for or interested in the protection of the surface and cleanliness of street pavements, and the ready accessibility of water, gas and other pipes to detect and stop leaks and do other necessary work.

The explosion in a manhole of one of the Baltimore electrical subways, on Nov. 11, emphasizes anew the need of having efficient ventilation for all subways and sewers in the streets of large cities. Of course, gas leakage should be prevented so far as possible; but there is bound to be considerable leakage from even the best-laid system of gas mains. Asphalt pavements, and concrete bases for first-class pavements generally, are gradually making the street surfaces more and more impervious to gas. Yet the gas will escape from the mains, and it must find an outlet somewhere, so it penetrates into subways, sewers and cellars. Where underground conduits are not ventilated, even small gas leakages may in time accumulate to such an extent as to make dangerous explosions quite possible, if not probable. A recent court decision placed the responsibility for the gas explosion in the Boston subway (March 4, 1897), on the local gas company (see Eng. News March 11, 1897, and Oct. 25, 1900). If this precedent is sustained elsewhere it will be well for all gas companies to look closely after their leaky mains.

The proposed repeal of the hopper water-closet restrictive ordinance by the Philadelphia city councils is a measure entirely without justification, so far as we can judge, and one that should be opposed by the press and the intelligent public of that city. The ordinance exacting a higher water rate for hopper closets than for self-closing fixtures was passed a year or two ago after a clear demonstration of the fact that the scores of thousands of such closets in the city were responsible for a part of the water waste for which Philadelphia is so notable. A large proportion of these antiquated and wasteful devices have been since replaced by modern appliances, but it is now proposed to repeal the ordinance, in order to save the extra water tax to those who have failed to comply with the intent of the ordinance. This is not only a poor lesson in civics to those citizens who have complied with the law, but it probably lets off the worst offenders; that is, those who are wasting the most water. In view of the immense sums to be expended for water purification in Philadelphia, and the many other public improvements needed, it is a shame that the city does not go much further in water waste prevention than it has, instead of proposing to retrace its first hesitating steps, which have been all too few and too short.

FALLACIES AND FACTS CONCERNING GOOD ROADS.

On another page of this issue we print an admirable paper by Prof. I. O. Baker, of the University of Illinois, in which some of the fallacies in the current "Good Roads" literature are clearly set forth. As many of our readers will remember, in our issue of Dec. 5, 1895, we criticised editorially the same misleading statistics which Prof. Baker, in his present article, has so thoroughly exposed.

These statistics were issued by the Office of Road Inquiry of the Department of Agriculture, and were first made public some five years ago. They are still being circulated, however, and we deem it well worth while, therefore, to give space to Prof. Baker's keen analysis, in which the falsity of these statistics is plainly shown.

That figures founded on so slim a basis of fact should have been issued as an official document by the United States Government is a matter worth especial comment. Statistics from such a source, especially where no partisan end can be served, are generally accepted without question by editors, speakers and writers, and by men of intelligence generally. It is not at all strange, therefore, that the statement that the construction of "good roads" would save $628,000,000 annually to the people of the United States has been widely quoted and accepted as authoritative. That this is a gross exaggeration, founded on nothing better than a wild guess, has now been clearly shown.

What the actual cost due to bad roads is, and what saving could be made by a general improvement of the common roads is, we believe, beyond the power of any statistician to determine.

The truth is that a great part of the "good roads" literature which has been circulated in such prodigious quantities has fallen flat because of its manifest absurdities and exaggerations.

Advocates of good roads have talked as if every common road, from suburban streets to the little-traveled roads in sparsely-settled farming regions, ought to be converted into a macadamized highway. They have run counter to common sense, as well as political economy, and the farmers of the country are much too shrewd and intelligent to be deceived by arguments of this sort.

It seems to us that the fact of greatest importance which the "good road" boomers have most conspicuously failed to grasp is that the character of every road should depend first of all upon the amount of traffic upon it. The pioneer, driving his train of immigrant wagons across the prairie, does not make any road. He drives wherever his teams can find the easiest course. Later on, a few settlers take up lands; and their wagons continue to follow the pioneer's trail, which is now used enough to make it worth while to clear away some stones at one place, corduroy a swamp at another, and level up a stretch of sidehill. As settlement increases the travel grows and more radical improvements are demanded. The road is relocated to avoid some hills; bridges are built; grading is done; ditches are provided for drainage. Later still the country becomes covered with valuable and productive farms; the road becomes, perhaps, a connection between populous villages, and it then becomes worth while to avoid the mud of the winter and spring season by covering the road surface with broken stone. Finally, on one part of its course a city grows up and the macadam will be replaced by a cleaner and more durable covering.

So far as the cost of hauling alone is concerned, each improvement in the character of the road has doubtless effected a reduction; yet each improvement has also necessitated a heavy expenditure, and has increased the annual cost of maintenance; and this cost will not be shouldered by those who have to pay the bills until the traffic upon the road is great enough to warrant it. It would be absurd for the first settlers to have built a macadam road, yet no more absurd than the plan of wholesale road improvement which many of the writers on "good roads" apparently advocate.

Another conspicuous claim of the "good roads" advocates is that because the annual expenditure on highways produces no stone-covered roads, it is, therefore, wasted. It is true that a large amount of unintelligent and ill-directed work is done in the repair and maintenance of ordinary highways; but the same thing may be said of almost any class of public works. On the other hand, it is a fact that the expenditure for highway improvement is controlled by the local users of the road who are most interested in its results. The principle of "home rule" is carried out to its fullest extent. The time and labor and money might be more intelligently expended in many cases, but only where the local circumstances warrant would it be wise to devote any considerable part of it to stone road construction.

Of course, if a stone road once built were good for all time with less annual expense for repairs than a dirt road, the situation would be very different. If that were true, it would be proper to devote as large a portion as possible of the annual expenditure on highways to hard road construction, thus aiming to eventually convert all highways into macadamized roads. Unfortunately, this is not the case. A good macadam road costs much more to keep in repair than a dirt road, and if it is not kept in repair it rapidly deteriorates and becomes for a good part of the year less pleasant to ride over and more destructive to horses and vehicles than a dirt road.

It ought to be entirely clear, therefore, that no road should be macadamized unless the traffic it will accommodate is sufficient in amount to justify the interest on the cost of the work and the annual charge for maintenance.

We are well aware that the "good roads" boomers have a whole arsenal of arguments as to the increase of population and traffic and the appreciation in land values which has taken place in districts in New Jersey and Massachusetts where a large extent of hard roads has been built; but these figures represent merely the change of a farming region into suburban towns and villages and market gardens. In such localities traffic has rapidly developed coincident with the growth in population, but it is absurd to ascribe any considerable part of either the increase in population or of land values to the good roads. It was really these changes that made the road improvement work possible.

So much for the fallacies. Now for the facts. It is true that the common roads of the country, taken as a whole, are by no means what they should be. It is true that with the rapid increase in wealth of the farming districts during the past four or five years—an increase which there is good reason to believe may continue—the way has been opened to secure a general improvement in the condition of highways in these portions of the country. It is true that the bicycle and the motor-vehicle have enormously increased the use of the highways for pleasure by residents of towns and cities, and have thus justified a greater expenditure on road improvement than was warranted a decade ago. It is true also that taxpayers in cities and towns, for these and other reasons, are willing to assist in the improvement of country highways, as they were not ten years ago.

But with these facts in mind, what policy should be pursued in carrying out road improvements? What roads should be improved, and how should the work be done?

At present the plan most in favor, where "state aid" to local road construction has been inaugurated is to build isolated samples of good road construction of the most expensive class with the expectation that these "object lessons" will induce the farming community to undertake similar works at their own expense. We believe that this expectation will seldom be realized. If these "sample roads" are located in a community where the first cost and the cost of maintenance of first-class stone roads can be afforded, they will doubtless be imitated; but in an ordinary farming community, the expensive stone road which the state builds would be regarded about as a present of a costly article of luxury would be by a man in moderate circumstances. He will use and enjoy it, but he will not buy more like it if it be really beyond his means.

At the root of this policy of building "sample roads" lies the idea that the farmers do not know what is for their own financial interests, and that "good roads" (by which is usually meant expensive stone roads), will result in sufficient financial gain to the farmers to more than counterbalance the first cost and the additional cost of maintenance. We believe this idea to be founded on just such misleading and fallacious statements as that put forth by the Road Inquiry Bureau. To the general policy of state aid to road improvement, objection can hardly be made. The wealth concentrated in the cities ought to bear a part of the burden of maintaining and improving the public highways. But such state aid should be so bestowed as to effect the largest results.

It is doubtful whether the policy of constructing isolated sections of roadway, scattered here and there, and all of the most expensive class of construction, is the wisest one. If a roadway of the highest class is to be built, then a location should be selected where the traffic justifies it. The attempt should be made, moreover, to form continuous stretches of roadway connecting populous centers. A network of such state highways may thus in time be formed which will justify the state's expenditure upon them by their service as general arteries of traffic, apart from their use to the immediate locality in which they lie.

The work that has been carried on in Massachusetts illustrates our point. When the policy of state highway construction was first adopted there, the "sample road" idea seems to have prevailed. The able Commission which has had charge of the work, however, has, in the exercise of its discretion, so chosen the roads for improvement that a few years hence will see the completion of a continuous state road extending from Boston to Worcester and thence westward to Springfield and the Berkshires; another will extend from Fitchburg westward to Greenfield; another will connect Boston and Providence; and a continuous road along the shores of Cape Cod and Massachusetts Bay is also in prospect.

While on roads with sufficient traffic the old adage holds that "the best is the cheapest in the long run," it is questionable whether the state should confine its work to the construction of high-class roads alone. Should not the remote farming districts which desire to improve their most used roads also receive aid from the state? And if this is done should not the road be suited in cost and in character to the traffic it has to carry? Is it true, as many good roads advocates seem to think, that there is nothing between the ordinary dirt road and the standard macadam construction? If this is really the case, then, the outlook for a general improvement in American highways is indeed discouraging. Massachusetts, for example, which is doubtless more wealthy in proportion to its area and more thickly populated than any other state in the Union has spent nearly 2¼ million dollars to secure only about 250 miles of state highways. At this rate how many years must elapse and how huge an expenditure must be made before such a state as New York or Virginia or Illinois can cover its territory with a complete system of good roads?

It seems to us that to confine the work of road improvement to the construction of high-class roads alone, is contrary both to sound engineering and to common sense. The great bulk of our highways must remain dirt roads, for one or two generations at least, if not indefinitely; but a great deal can be done to improve their condition and facilitate travel over them without resorting to macadam construction. The intelligent use of road machines, provision for drainage, removal of soft mud and replacement with more stable material are examples of work which can be done at very moderate outlay, and which will often repay its cost in decreased expenditure for road repairs. Where a road has a large enough traffic to justify greater expenditure, gravel top dressing can often be applied in glacial regions at a small cost; or a narrow telford foundation may be placed, where the soil makes such a foundation advisable. Local conditions will, of course, determine local requirements. There are sections of the country where the natural soil forms an admirable road for moderate traffic during the greater part of the year. There are others where the roads become quagmires at every heavy rainfall, and in such districts of course the need for road improvement is far more urgent, and expenditure in this direction is far more justifiable.

If the state is to do the most for the improvement of public highways, it ought to aid in the improvement of the ordinary highways as well as in high-class macadam construction. There are thousands of miles of much-traveled highways in almost every state on which an expenditure averaging, perhaps, $500 per mile would produce large results, especially if the work were supervised by a competent engineer, as would naturally be required if the state were to bear part of the cost. It may be argued that this expenditure would not be a permanent improvement like the construction of a macadamized road; but the real way to measure permanence is by the necessary expenditure for maintenance. If either road were left to wear out with no expenditure for maintenance for ten years, it is a question whether a larger percentage of the expenditure on the costly road or on the cheap one would remain intact.

It must be clearly understood that we are by no means arguing against the construction of macadam roads. Where the traffic warrants them, they are without doubt the road to build. What we protest against is the idea that no other class of road improvement is worth the attention of engineers or deserving of aid by the state.

It cannot escape attention, moreover, that in work of this sort the state can secure local cooperation as it cannot on the more expensive roads. In Massachusetts the state pays three-fourths of the cost of the state roads, which average nearly $9,000 per mile in cost.

Suppose that in a state where a much larger mileage was to be covered and funds were less readily available, it were determined to spend $500 to $1,000 per mile in improving main highways. At such a rate one-half the cost could well be

borne by the locality benefited and a given appropriation by the state could be made to cover a large extent of territory. It may perhaps be contended that such an expenditure is more than could be profitably made on ordinary dirt roads. If this is the case, make the expenditure less and cover a larger territory. The only point we contend for is that it is feasible to effect great improvements in ordinary earth roads at a moderate expenditure and that it is worth while for the state to foster such work by financial and other aid.

LETTERS TO THE EDITOR.

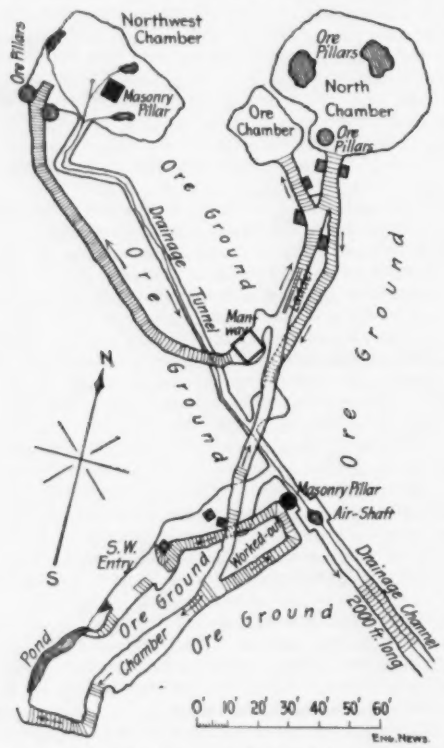
The Havana Sewerage System.—Correction.

Sir: The article in Engineering News of Nov. 1, on the Sewerage and Paving of Havana, Cuba, states that "The plans for the sewerage of Havana were generally drawn up by Mr. D. E. McComb, under Mr. S. M. Gray, acting as consulting engineer. While Mr. McComb devised a combined system of sewerage, Mr. Gray has changed this to a complete separate system." In justice both to Mr. Gray and to myself, and that our relations to the work may be understood, I desire to state that Mr. Gray's connection with the work was subsequent to mine, and was after my plans and report had been presented to the Chief Engineer of the Department of Havana. My report did not contemplate the installation of sewers on the combined system throughout, but proposed the combined system for portions of the territory covered and the separate system for other portions. Very truly, D. E. McComb.

Washington, D. C., Nov. 1, 1900.

The San Rafael Sulphur Mine, Mexico.

Sir: The accompanying drawing is a sketch map of the San Rafael Sulphur Mine, located near Cerritos in the Province of San Luis Potosi, Mexico. In view of the primitive manner in which this mine has been worked and of its curious shape I have thought that a brief description might perhaps be of interest to some of your readers. At the lowest level this mine is 100 ft. deep and entrance to the workings is gained by a series of winding stairways cut out of the solid ore. The workings are ventilated by an air shaft reaching to the bottom level and located 52



Sketch Map of the San Rafael Sulphur Mine, Near Cerritos, Mexico.

ft. from the entrance. When the mine was worked by the Mexicans the ore was mined from the various chambers or rooms and brought to the surface in hide sacks or bags on the backs of peons, where it was smelted in a very crude manner in primitive smelters. This method of operating the mine was obviously very slow as it has been worked on and off for 50 years, and yet only a very small area has been worked out, as may be seen from the sketch.

One of the most interesting and curious features of this mine is the method of supporting the roof. The roof supports, except in two cases, are circular pillars of ore. The two exceptions are as follows: In the northwest chamber there is a 5 x 5 ft. square pillar of masonry, and near the air shaft there is a circular pillar of masonry. The masonry work in these two pillars is good and must have been tedious and expensive to build since the pillars are nearly 75 ft. high.

The mine is drained by a tunnel or "socavon" cut through ore and rock for nearly 2,000 ft., to an "arroyo." This tunnel has a good fall and drains the mine perfectly. The amount of work done in this mine, cutting stairways, driving the tunnel, building the masonry pillars, etc., for the small amount of sulphur removed shows that the cost of labor must have been small. The laborers were peons, who were paid from 20 cts. to 35 cts. per day, Mexican money.

The survey of this mine was rather difficult owing to the winding stairways and narrow passages. For this work a pocket compass and tape were used. A transit lowered down the air shaft was used to locate the drainage tunnel. The transit work was carried up the tunnel to the northwest chamber, where it was tied up with the compass survey, and considering the conditions the work of the two surveys checked closely. This mine is now owned by the Virginia-Carolina Chemical Co., of Richmond, Va., which will thoroughly develop it.

Very truly yours, H. L. Cumming, C. E.

Cerritos, S. L. P., Mexico, Oct. 25, 1900.

Difficulties in Securing Business in France.

Sir: During the past year in Paris, where I have had charge of a machinery exhibit at the Exposition, I have had an excellent opportunity to observe business conditions and business methods here; and a few notes from my experience may perhaps be of interest to some of your readers.

It is true that there appear to be splendid opportunities here for the establishment of profitable enterprises, and many American houses have already established successful branches in Paris. At the same time any firm contemplating extension of its business to this field should understand that the difficulties to be encountered by its representatives at the outset are very great.

The character of the people is so different from the English, German or American that doing business of any sort is uphill work. I attribute it to a lack of courage or the disinclination to decide upon and attempt anything which is not perfectly familiar. "Suppose this happens?" "it is such a departure," "I have never seen it done," are common expressions, whereas an American under similar circumstances, would say: "That is a good idea; I'll try it and if it does not work quite as satisfactorily as we expect, we will work it out somehow; any way, we will make the effort." These people see all the difficulties piled up at the start, and entirely forget that these same difficulties would, in reality, come one at a time and could thus be met and disposed of singly.

Again, they are too theoretical and will quibble over details and lose sight of the results. To illustrate this: One man was interested in one of our machines which was turning over at about quarter speed. I casually remarked that its normal speed was 150 revolutions per minute. "Impossible," he replied. "Not at all," said I, "you will notice that it is listed in our catalogue at 150 revolutions per minute." He persisted that this was out of the question; so to settle the matter I had my engineer run it at 200 turns for three or four minutes. Turning with the smile of a conqueror, I was met by the remark, "Oh, well, that is only for a few minutes." The argument that we had many machines in operation at that speed had no weight. I could not convince him and there was an end to it. This, of course, was a somewhat extreme case, but it is characteristic.

Then, again, engineers of reputation will haggle over steam consumption and worry themselves and you to the profane stage, while the question of first cost, final results, durability and all that makes true efficiency of an equipment mildews from neglect.

Besides this, when once convinced, they are not always of the same mind; and when the magnetic influence of your logic no longer surrounds them, they lurch out of the straight road and fall by the wayside in a quagmire of imagined difficulties which necessitate more logic and an amount of mental effort sufficient to boil water.

A repetition of principles, reasons and powerful arguments administered about four times, at periods of about a month, may or may not bring matters to a head. If it does you bear off an order for a machine (on trial).

Six months of this life would wear six-inch wrinkles into the smiling face of the most winning Yankee drummer who ever rattled over American rails, especially when he realizes that the heads of the firm at home know nothing of the labor he is expending and the difficulties he is encountering, and suspects that they are exchanging sage remarks on the effect of life in Paris to lure examplary young men from the paths of industry and devotion to business!

Truly yours, "Champ de Mars."

Paris, Oct. 21, 1900.

Teaching Mathematics in Engineering Schools.

Sir: I have followed with interest your recent editorial and the published letters relative to the teaching of theory and practice in schools of engineering. The suggestions are pertinent for engineering educators. Some of the inherent faults of our engineering schools have been discussed and the onus is as often laid upon the student's mathematics. The trouble is not with this branch of science, but rather with the system in vogue in our universities in contradistinction to that of the schools of technology.

In our universities, the mathematical work is largely in charge of teachers who study it "for art's sake" rather than as a tool or means to an end (with due respect to the gentlemen). Pure mathematics and applied mathematics have divergent aims. The pure mathematician looks upon the engineer, physicist, and even astronomer, as one who debases the science of mathematics to utilitarian ends. Your correspondent, "Practical's," idea of the mathematician is quite typical.

During the first two years of college the embryo engineer studies pure mathematics with the mathematicians. He is introduced to modern algebra, trigonometry, calculus, least squares, etc. It is too often the result that the hard-headed young American, who is seeking knowledge upon a business basis, finding that the subjects seem to have little practical value, slights them to his future regret. If the instructor can show this future business man a proper application for these subjects, he will find that what seemed at first stupidity was more probably lack of interest.

Now in the technical school this is different. The instructors are usually men of more or less practical experience in engineering who see science and mathematics in their true perspective and are able to lead the student to appreciate the relative importance of the various steps he is taking which may have bearing upon future practice. The text books are also framed to that end. For example, Crockett's "Trigonometry," while not departing or dodging one principle usually taught in that subject, is so arranged that a great many practical cases are introduced, and the future engineer, seeing that later some profit may accrue for his present expenditure of time, will exert himself upon the study notwithstanding his inaptitude.

Most of our great mathematicians were men of considerable common-sense. Their investigations were nearly always prompted by some concrete case in mechanics. Mathematics properly digested can never harm an engineer. But to use it as a tool, it should be properly assimilated and correlated with applied science.

The writer believes that there is opportunity for many of the improvements suggested in your editorial. Along this line might be suggested a reversion to more science. Any one who examines the curricula of our engineering schools, will note that there is a gradual elimination of pure science with the substitution of technology in its place. There are the departments of Sanitary, Irrigation, Ventilation, or Municipal engineering. The professor of these departments invests his subject with a gravity that is more apparent than real. Machine design reduces to tedious empiricalism what is usually simply applied mechanics.

Dr. Van Hise, formerly Director of the Geological Survey of Michigan, relates how a father, desirous of having his son succeed to his business of dyeing took him to Liebig, the chemist, with instructions to teach the young man dyeing. After considerable remonstrance from the chemist as to his ability to teach dyeing, he finally said: "Send me your son for three years, and I will teach him chemistry. This done, when he goes into your dyehouse, he will know more about the technology of dyeing in a few weeks than any man you now have."

Upon graduation, the young engineer who has done much specializing finds too often that he is "sidetracked" at the start. The need of specialists is subject to economic laws, so that he usually must take what comes. Our oldest technical institute has maintained a policy from which it has not been swerved by the popular demands for specialties. Here the main course is civil engineering, but it is made sufficiently elastic to include what is called mechanical and electrical engineering, and much science. The Clarkson School of Technology also has its civil engineering course extended in scope to include much in this line.

The writer recalls how after graduation from a specialized course in civil engineering he was given considerable work of a mechanical engineering nature, with the result that he found himself handicapped by lack of knowledge of some of the most elementary principles of mechanism. The electrical engineer may often be called upon to do the work of a civil engineer in electric road work or in power plant design, or the mechanical engineer may go far into the domain of civil engineering in mill building design. Yet in any one course the essential studies of the other courses are too often reduced to a minimum. The civil engineering student should be made familiar with the steam engine, and the mechanical engineer with the strain in trusses or arches.

The writer believes that there should be more science and well-digested mathematics. With a few exceptions

the technology will take care of itself. If there be anything more, let it be law and finance.

John H. Griffith.

Clarkson School of Technology, Potsdam, N. Y., Nov. 3, 1900.

What the Engineering Schools Should Teach.

Sir: I have read with much interest your remarks and those of Prof. Johnson on engineering education in your issues of Oct. 18 and Oct. 25. It has been my duty and privilege to have more or less to do with "breaking in" a great many engineering graduates into practical engineering work. I have come thus in contact with graduates of most of the American and some European institutions. I have always found it necessary to put them through about the same course of training that I would a high-school graduate. Their progress is very much more rapid, but their real practical knowledge at the start is almost nil; they cannot even add rapidly and correctly.

I am pursuaded that the proper sphere of the engineering college is to teach scientific principles and drill them thoroughly into the minds of the students, avoiding specializing as far as possible and thus lay a broad and sure foundation for subsequent practice; they can learn these things to far better advantage in college than anywhere else. It is well to remember that the leading engineers of 1940 are students to-day, and no man knows what changes may take place in engineering in forty years. The various branches of engineering are so interrelated that it is impossible to separate them completely; see how important a knowledge of electricity is to an engineer nowadays; it was not so thirty years ago.

As to acquiring practical knowledge and skill, if the graduate is wise he will accept nothing but a subordinate position at first, then he will have to do as he is told anyhow. He will come in contact with practical men and by a vigorous use of his eyes, ears and brains as well as his hands, he will attain to the desired proficiency. Practice will consist largely of exemplifications of scientific principles with which he is already familiar and a great deal that is new to him will be things that he might have known already if he had only thought of them. Practical knowledge consists mostly in the acquisition of an immense number of facts which can be learned far better by contact with the work and with practical men than in any school. Another reason why I consider any practical instruction that can be given in college to be of little value is that engineering practice changes almost from day to day, and a method learned at college is apt to be obsolete by the time the student has a chance to apply it. The most expert engineers get jobs every day that they do not know how to do—they have to invent ways to do them and then decide among the various ways thus invented which shall be adopted. The mental training received at college, supplemented by the practical knowledge and skill acquired in later years, is largely what fits them to do this.

I am inclined to think that a course in engineering should embrace as thorough a course as possible in mathematical, physical and chemical science, without excluding natural science, and including both class and laboratory work. The graduate should be able to read technical books with reasonable facility in at least two foreign languages. In addition, some knowledge of finance and of the law relating to contracts and municipal officers will always be of great service. A reasonable amount of aesthetic training will certainly not be out of place. There is another study which is of vital interest to every engineer—I am not aware that any scientific basis for it has yet been established, I suppose that will be a part of the work of the twentieth century—that study is Man. If any scientific principles of human nature are ever discovered, they should certainly be taught in every engineering school. A reasonable amount of concrete study in that line would be extremely useful. Other things might be added if practicable, but the course should not be overburdened; thoroughness is more important than quantity. I know such a course of study as that would hardly appeal to the average parent, but I think it would be the best in the long run.

College professors have not the time, the ability, nor the facilities for teaching practical work, it can best be learned by contact with practical men, both directly and through the medium of their writings, and by engaging in actual work on a commercial scale. This last also accustoms the young man to responsibility, a very important part of his training.

As to mathematical formulas, it must not be forgotten that no branch of knowledge is truly scientific unless it is mathematical; that is, unless all its elementary units and the relations between them can be accurately determined, so that the phenomena of which it treats can be precisely measured and compared. Frequently the development of a science involves much complicated mathematical work. It should be borne in mind, however, that mathematics is simply a reasoning machine, and the student should accustom himself, so far as possible, to translating the mathematical processes into ordinary logic and expressing the results in ordinary language. This last is precisely what the practical man does, either consciously or unconsciously, so that the professor's formula becomes his method with which he has become familiar and can remember much better than any formula. Mathematical gymnastics are all right if they serve to explain or illustrate a principle or to fix it in the mind of a student, otherwise they are useless, except for the mental discipline they afford, and this may be easily overvalued. Mathematics is in any event a means rather than an end.

A mathematical mind is absolutely necessary to a successful engineer, but by a mathematical mind I mean one that has a thorough instinctive appreciation of quantities and the relations between them and not one that is crammed with formulas.

Very truly yours,

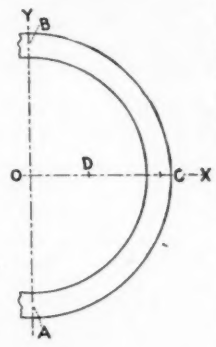
Willis Whited.

Pittsburg, Pa., Nov. 7, 1900.

The Bending Moment in a Circular Girder.

Sir: In your issue of Sept. 20 a correspondent requests a derivation of the bending moment at any point of a girder, bent in the form of a circle, resting on four equidistant supports, the points of support being in the same horizontal plane, the girder being uniformly loaded. A solution is given below. It is fortunate that the load is uniform; otherwise difficulties would be encountered analogous to those arising in the discussion of continuous beams.

Consider the equilibrium of half the girder, imagining it to be cut just to the left of A and B, two of the points of support. Let r be the distance from O to the center of gravity of a section of the girder cut by two planes through O very close together. This point will be a little further out than the center of area of the cross section of the girder, but if the width of the girder is small in comparison with its radii, the difference is immaterial. I will make the supposition that the reactions of the supports act at this radius; it gives simpler results, and is substantially correct. D is the center of gravity of the half-ring; then $OD = \frac{2r}{\pi}$. Also, let W be the total weight of the girder and its load. The X and Y coordinate axes are shown in the figure, the Z axis being perpendicular to the plane of the paper at O.



The forces holding the half-ring in equilibrium are the reactions R_a, R_b, R_c, at A, B, C, respectively, vertically upwards, the weight of half the ring vertically downwards at D, and the internal reactions of the left half of the ring on the right half at A and B. Since any system of forces can be reduced to three component rectangular forces acting at any desired point and three couples whose axes are at right angles, we can consider the internal reaction at B to be:

A force parallel to the X axis L_1;
" " " Y " L_2;
" " " Z " L_3.

A couple whose axis is parallel { to the X axis of moment M_1; " Y " " " M_2; " Z " " " M_3.

L_1 represents a longitudinal compression or tension.
L_2 " " horizontal shear.
L_3 " " vertical shear.
M_1 " " torsion moment.
M_2 " " vertical bending moment.
M_3 " " horizontal bending moment.

From symmetry the internal reaction at A is:

A force parallel to the X axis L_1;
" " " Y " $-L_2$;
" " " Z " L_3.

A couple whose axis is parallel { to the X axis of moment $-M_1$; " Y " " " M_2; " Z " " " $-M_3$.

From symmetry each of R_a, R_b, and R_c is equal to $\frac{W}{4}$.

We now apply the six equations of equilibrium: Summing the X components gives $2L_1 = 0$, or $L_1 = 0$. Summing the Z components gives

$$2L_3 + R_a + R_b + R_c - \frac{W}{2} = 0;$$

whence $L_3 = -\frac{1}{8}W$.

Summing the moments about the Y axis gives

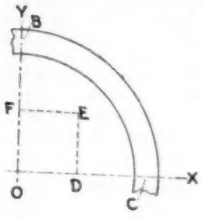
$$2M_2 - R_c r + \frac{W}{2}\frac{2r}{\pi} = 0;$$

whence

$$M_2 = \frac{Wr}{2}\left[\frac{1}{4} - \frac{1}{\pi}\right].$$

The remaining three equations give us nothing.

Consider, now, the equilibrium of the quarter-ring shown in the second figure. The forces acting are R_b and R_c, the internal reactions at B and C, and the weight $\frac{W}{4}$ of the quarter-ring acting at its center of gravity E. Then $FE = ED = \frac{2r}{\pi}$. From symmetry the internal reactions at C are the same as those at A rotated 90°, hence consist of:



A force parallel to the X axis, L_3
" " " Y " $L_2 = 0$.
" " " Z " L_3

A couple whose axis is parallel { to the X axis of moment $-M_2$; " Y " " " $-M_1$; " Z " " " $-M_3$.

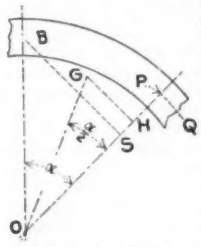
We now apply the equations of equilibrium.
Summing the X components gives $L_3 = 0$.
Summing the moments about the Y axis gives

$$M_1 - M_2 + R_b r - \frac{W}{4}\frac{2r}{\pi} + L_3 r = 0;$$

whence $M_1 = 0$.

The remaining four equations reduce to identities.

We have thus shown that the internal reaction at B consists of a vertical shear L_3, a vertical bending moment (that is, one of horizontal axis) M_2, and a horizontal bending moment M_3. The last is yet undetermined. Imagining the beam to be cut at B, we must consider these to be external forces. We now proceed to find the stress at any section as at P in the third figure. The external forces to the left of the section are L_3, M_2 and M_3 above mentioned, the reaction of the support at B, and the weight of the arc B P acting at its center of gravity G. Then $OG = \frac{2r \sin \frac{1}{2}\alpha}{\alpha}$, and the weight of B P is $\frac{W\alpha}{2\pi}$, α being measured in radians. Taking the components of the external forces parallel to O P, P Q, and the Z axis, we find, respectively, that at P there is a horizontal shear = 0.



A longitudinal tension or compression = 0.

$$\text{A vertical shear} = L_3 + R_b - \frac{W\alpha}{2\pi} = \frac{W}{2}\left[\frac{1}{4} - \frac{\alpha}{\pi}\right].$$

It is here supposed that α can vary between 0 and $\frac{\pi}{2}$. One quadrant being solved, the others follow from symmetry. Taking moments about O P, P Q, and an axis through P parallel to the Z axis we find, respectively, that at P there is:

A vertical bending moment

$$M = M_2 \cos\alpha + (L_3 + R_b)\,\overline{BS} - \frac{W\alpha}{2\pi}\,GH.$$

A horizontal bending moment = M_3.
A twisting moment

$$T = -M_3 \sin\alpha - (L_3 + R_b)\,\overline{SP} + \frac{W\alpha}{2\pi}\,HP.$$

Substituting the values of L_3, R_b, and M_2 already found, and the values of $\overline{BS}$, $\overline{GH}$, $\overline{SP}$ and $\overline{HP}$ from the figure in terms of r and α, and making use of the formulas $2\sin^2\frac{1}{2}\alpha = 1 - \cos\alpha$ and $2\sin\frac{1}{2}\alpha\cos\frac{1}{2}\alpha = \sin\alpha$, we find

$$M = \frac{Wr}{8}(\cos\alpha + \sin\alpha) - \frac{Wr}{2\pi}.$$

$$T = \frac{Wr}{8}(\cos\alpha - \sin\alpha - 1) + \frac{Wr\alpha}{2\pi}.$$

M has a maximum value of $\frac{Wr}{8}\left\{\sqrt{2} - \frac{4}{\pi}\right\}$ when α equals $\frac{\pi}{4}$, and a minimum value of $\frac{Wr}{8}\left\{1 - \frac{4}{\pi}\right\}$ when α equals 0 or $\frac{\pi}{2}$. T is zero when α equals 0, $\frac{\pi}{4}$ or $\frac{\pi}{2}$, has a minimum value of $-0.0053\ Wr$ when α equals 70.8°, and a maximum value of $+0.0053\ Wr$ when α equals 19.2°.

It is easy to see that the only undetermined quantity, M_3, is equal to zero. For the horizontal bending moment being always equal to M_3, if M_3 does not equal zero the ring will be strained into a new circle, larger or smaller, according to the sign of M_3. But this will change the circumference of the circle, and hence must be accompanied by a longitudinal tension or compression. But the latter has been shown not to exist; hence $M_3 = 0$.

The preceding determines the straining forces at any

point of the girder. It should be noted that the customary formulas giving the relations between these straining forces and the maximum fiber stresses in straight beams would not necessarily apply to this case. If, however, the width of the girder is small in comparison with its radii, the formulas will be sufficiently accurate.

G. P. Starkweather.

Yale University, New Haven, Conn., Sept. 25, 1900.

Shrinkage of Earth in Embankments.

Sir: I have noticed with interest,in your issue of Oct. 25, Professor Johnson's arraignment of the Editor of Engineering News and a certain critic of the Professor's book. The Editor of the News is in no mild language condemned because he permitted the publication of a letter from an engineer of whom Professor Johnson had never heard, and whose name indicates a foreign parentage (and what American's name aside from an Indian's does not?), and who on that account is, according to Professor Johnson, incompetent to criticise American schools of engineering or American practice.

Does Professor Johnson believe that his book is so perfect that no obsolete methods are to be found therein? It would be a simple task to disillusion him if he believes that to be the case. At present, however, I only want to call attention to an error of fact: On page 441 of his "Surveying" [468 in the last edition] we find the following rule:

> But a contractor should have his stakes or poles set one-fifth (20%) longer than the corresponding fill, so that when filled to the tops of these a settlement of one-sixth (16⅔%) will bring the surface to the required grade.

I recall one instance at least where an engineer compelled a contractor to follow the above rule and without recompense for the additional earth required which, since the earth did not settle appreciably, meant a loss of several thousand dollars to the contractor. The engineer, by the way, was another college professor.

Professor Johnson is hereby challenged to present evidence showing that an earth embankment constructed as embankments ordinarily are by means of horses, wagons, and scrapers, ever shrinks 16⅔%. The experience of the writer is that 2 or 3% is nearer an average shrinkage. Professor Johnson's rule is probably based upon the experiments of Elwood Morris (1841) which indicated an earth shrinkage of 8 to 15% when taken from a cut and placed in a fill; but the Professor has overlooked one small factor, to wit: The shrinkage takes place almost entirely during construction and not afterwards. It is the pounding of hoofs and wheels that compacts the earth and not the subsequent action of rains and earth pressure.

Let not Professor Johnson think that the writer condemns his excellent book as a whole, but let him not reply that he never heard of the writer before and flatter himself that he has thus answered his criticism. The writer trembles lest Professor Johnson look up his family tree and discover that he has French or Irish blood in his veins, and should therefore be debarred from criticism of American works!

H. P. Gillette.

Rochester, N. Y., Oct. 31, 1900.

(Proof of the above letter was submitted to Professor Johnson, and we append his reply, as follows:—Ed.)

Sir: Replying to the "challenge" given in the above communication, I would respectfully refer the writer to a continued article on "Shrinkage of Earth Work," by Mr. P. J. Flynn, read before the Technical Society of the Pacific Coast, June 5, 1885, and published in Engineering News, May 1 and 8, 1886. This is the paper referred to in a footnote in my work on "Surveying" on the pages cited by the writer of the above communication. If he had examined the data given in this paper, he probably would not have issued his "challenge." Here are brought together a vast number of results of experiments as well as rules for allowing for the swelling and shrinking of earth work. The subject is too large a one to enter upon here, but is fully discussed in the paper referred to. It is true that few actual measurements have been made of the actual swelling of earth work when first dumped and of the final shrinkage of the same. In preparing this article in my book on "Surveying" in 1885-'6, I considered the data given in this paper of Mr. Flynn's as the most reliable then obtainable. From this I found from careful experiments made by Mr. Specht, in California, that ordinary sandy loam swelled by actual measurements 9.4% when first placed in embankment by means of horses and scrapers, the volumes being 53,350 cu. yds. in cut, to 58,350 cu. yds. in fill, or an increase of 9.4%. Various and sundry authorities are quoted in this same paper to show that the final volume in a settled embankment of clay or sandy loam is on the average about 10% less than the volume of the cut from which the material was taken. Putting these two facts together, as Mr. Flynn does, he shows that since the embankment when first completed is 9% greater in volume than that of the cut, and finally shrinks to a volume 10% less than that of the cut, that the total shrinkage from the time it is first completed when built up with horses and scrapers would be about 19%. He, therefore, states that "in order to have a permanent depth of 40 ft. after settlement, an embankment of the material just described (sandy loam), would require to be built 48.5 ft. in depth at first." Mr. Flynn gives this as his best judgment in view of all the facts presented. This quotation is taken from the middle of the third column on page 289 of the issue of Engineering News, May 8, 1886. For fear these values were still a little too high, I reduced them slightly and made my rule as follows, which is given in italics: "For ordinary clay and sandy loam, dumped loosely, the first increase is about one-twelfth, and then the settlement about one-sixth of this increased volume, leaving a final volume of about nine-tenths of the original volume in cut." The authority for this is given in a footnote referring to the paper by Mr. Flynn herein quoted. The reader will please observe that my rule is also additionally guarded by the expression "dumped loosely." While in Mr. Flynn's article he does not usually describe the method of making the fill, in one place he speaks of Mr. Specht's work as having been done by scrapers. In my opinion this alone does not sufficiently define the character of the fill for the purpose of estimating shrinkage, for a deep fill made by a scraper in horizontal layers over the entire area, would evidently be much better compacted and, therefore, would shrink much less, than if the dump were made continuously from one end and from the grade level. My rule also is made to apply to the final shrinkage, which is not the shrinkage at the time of the completion of the embankment, but the shrinkage which will ultimately occur in the course of a few years' time. All engineers are familiar with the sags which are found on new lines of railway on each side of bridges and culverts where there is a fill of 10 ft. or more in height. These frequently amount to as much as several feet, depending upon the height of the embankment, and they necessitate constant adjustment and grading up for the trackmen for several years after the completion of the line.

Probably in no other kind of earth work is shrinkage more carefully attended to than in the building of levees. Here it is the final absolute grade of the top of the levee which is significant, and hence the levee embankments are always intended to be made high enough to cover the shrinkage. These levees are constructed with scrapers or wheelbarrows and are also built up in horizontal layers, with great care, for the purpose of obtaining solid embankments. Notwithstanding the care taken in spreading the earth in horizontal courses, and the fact that these courses are worked over constantly, a vertical shrinkage of 17% is allowed for embankments in clay or loam. This is also quoted by Mr. Flynn near the bottom of the third column on page 278 of Engineering News, Volume XV. From these and other facts given in the article above quoted, I think I have offered full justification for the rule given in my work on "Surveying." This rule, as in the case of all others, must be applied with judgment and its appropriateness in any given case must be determined with reference to the character of the material and the methods by which it is handled and placed. This every engineer must do for himself. In view of what is offered above, and from the fact that this same paper by Mr. Flynn is given in the original in my "Surveying" in a footnote as authority for the rule, I think my challenger is hardly justified in saying "Professor Johnson's rule is probably based upon experiments of Ellwood Morris (1841) which indicated an earth shrinkage of 8 to 15% when taken from a cut and placed in a fill."

J. B. Johnson.

Madison, Wis. Nov. 5, 1900.

BOOK REVIEWS.

ENGINEERING STUDIES.—Part II. Roman Stone Arches. By Charles Evan Fowler, M. Am. Soc. C. E. Engineering News Publishing Co., New York, N. Y. Paper; 7 × 10½ ins.; pp. 15; illustrated. 25 cts.

The second number of this series of engineering studies, like the first, which was published some time ago, relates to stone arch bridges, but while the first number referred entirely to notable stone arches of modern construction, the present number harks back to the days of the Roman Empire and the remarkable aqueducts and road bridges built by Roman engineers and their immediate successors in Southern Europe. Altogether eight different stone arch structures are illustrated by well-printed half-tone plates, and the bridge shown is in each case concisely described and its aesthetic features pointed out.

REPORT UPON THE EXAMINATION OF RESERVOIR SITES IN WYOMING AND COLORADO.—By Hiram M. Chittenden, Lieut.-Colonel U. S. Volunteers, Captain Corps of Engineers, U. S. A. Being Appendix PP of the Annual Report of the Chief of Engineers for 1898. Washington, D. C. Paper; 5¾ × 9 ins.; pp. 2815-2922; maps and illustrations.

This report has been already noted in our issue of Oct. 6, 1898, but Captain Chittenden now informs us that the notice caused an extensive demand for the document and the entire edition was exhausted. The last Congress ordered a new edition of 3,000 copies to be printed, and these are now ready for distribution. Any of our readers desiring to secure copies should apply to some member of Congress. This report covers not only a detailed examination into reservoir sites in the arid and other regions in Wyoming and Colorado, but it also discusses dam construction, natural and artificial reservoirs, flood protection, cost of work, etc. It is illustrated with maps and plans and photographs of completed works of this character.

THE BURIAL OF THE APPRENTICE.—A True Story from Life in a Union Workshop, and other Essays on Present Political and Social Problems. By Henry W. Cherouny. New York: The Cherouny Printing & Publishing Co. Cloth; 6 × 9 ins.; pp. 193. 75 cts. in cloth; 25 cts. in paper.

In his preface the author states that this book is made up of a number of papers, written between the years 1885 and 1900,

> suggesting the abolishment of the custom of determining the terms of labor through verbal contracts concluded by individuals and the introduction of the system of settling the conditions of labor through formal contracts concluded by unions of employing and working craftsmen.

Although written chiefly from the standpoint of printers, employers and employed, many of the observations and suggestions made in this book are of general application to other trades.

A TEXT-BOOK OF THE MECHANICS OF MATERIALS AND OF BEAMS, COLUMNS AND SHAFTS.—By Mansfield Merriman, Professor of Civil Engineering in Lehigh University. Ninth edition, revised. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 398; illustrated. $4 00.

That this text-book should have reached its ninth edition is sufficient evidence of the wide appreciation of the value of this treatise to the student. It is especially designed for the use of classes in technical schools and colleges pursuing an elementary course of study in the resistance of materials and the mechanics of beams, columns and shafts; its treatment presupposes a good training in mathematics and theoretical mechanics, and is intended to be accompanied or followed by detailed exercises in construction and design. This last edition brings the work fully up to the latest theory and practice; new matter has been added relating to the eccentric loading of columns, formulas for repeated stresses, spherical and cylindrical rollers, the oscillations of bars and beams under impact, etc.

L'INDEX DU COMMERCE AMERICAIN.—Liste descriptive et classifee des membres de L'Association Nationale de Manufacturiers des Etats-Unis. Arrangee pour la Commodite des Acheteurs Etrangers. Philadelphia: National Association of Manufacturers. Cloth; 6 × 8¼ ins.; pp. 670. Price, $5 in United States; free to foreign business houses.

The third edition of this American Trade Index is printed both in French and in English, and an edition of 7,500 copies is now being gratuitously distributed by the National Association of Manufacturers among the principal business houses in the world. Its sole purpose is to bring the members of the Association into close touch with foreign buyers. And to this end the American business firms forming the Association are arranged alphabetically and from five to twelve lines or more of text are devoted to explaining the nature of the business of each. An alphabetical list of articles produced by the members of the Association is appended, with a list of firms under each article; this list is given in both French and English. The value of such a trade index is obvious, as a practical means of reaching foreign buyers and consumers.

THE WINSLOW TABLES.—Diagrams for Calculating the Strength of Wood, Steel and Cast-Iron Beams and Columns. By Benjamin E. Winslow, Architectural Engineer, Chicago Board of Education. New York: The Engineering News Publishing Co. Cloth, 12 × 9½ ins.; pp. 10; 19 plates. $1.

The character and purpose of this book is explained by the author in his preface as follows:

> The author's purpose in preparing this work is to furnish to engineers, architects, and others interested in construction, a rapid and easy means of computing the sizes of beams and columns by the use of graphical tables. It is believed that this work is the first publication of its kind which has aimed to cover the whole ground so as to include all ordinary cases that are likely to occur in building construction. No attempt has been made to deal with complicated engineering problems or with such as are of infrequent occurrence, nor has the author thought it advisable to recommend the safe working stresses to be used in any special case. In order to place the diagrams before the public in as practical shape as possible no labor has been spared. To increase their accuracy, all the diagrams have been reproduced from large drawings, and the positions of all the lines have been repeatedly checked over with the greatest care, so that their correctness may be entirely relied upon. The author has used the tables daily for several years, with great saving of time and labor, in making calculations of strength for the public school buildings of Chicago, and for other buildings of importance.

MUNICIPALITIES VS. PRIVATE CORPORATIONS.—Political and Business Management Compared. With Tables Showing Cost of Lights Furnished by Private Companies and Municipal Plants, a List of Municipal Plants Sold or Abandoned, Experience of Municipalities, Legal and Editorial Opinions. By M. J. Francisco. Rutland, Vt.: M. J. Francisco & Son. Paper; 6 × 9 ins.; pp. 172; tables. $1.

The author is pretty well known among those interested in electric lighting plants as a strong opponent of municipal ownership. He states in his preface that after "twelve years' practical experience in electric lighting" he sold his plant and that he now has no connection, direct or indirect, with any electric lighting company. Nevertheless, this pamphlet is quite as partisan as though it were written by an attorney or a stockholder in an electric lighting company, in the midst of a bitter fight

against the establishment of a competing municipal plant. But with all his partisanship, the author seems to be sincere and he also seems to have taken much pains to secure reliable figures to prove his case, although carefully excluding all evidence on the other side. Bearing these limitations in mind, we recommend the pamphlet to all students of questions of municipal ownership, as being a good presentation of the chief arguments against municipal ownership, accompanied by a well-stocked magazine of ammunition for this verbal fight, in the way of statistical description of alleged municipal ownership failures and quotations from authors and newspapers. Unfortunately, there is a general absence of dates and authorities for the reports on municipal failure and for the tables given, which show the comparative cost of private and municipal ownership.

FREEHAND PERSPECTIVE.—For Use in Manual Training Schools and Colleges. By Victor T. Wilson, Graduate of the Pennsylvania Museum and School of Industrial Art; Instructor of Drawing in Cornell University. New York: John Wiley & Sons. Cloth; 9 × 6 ins.; pp. 257; illustrated. $2.50.

While the author entitles his work freehand perspective, it is really a treatise on freehand drawing based upon a thorough understanding of the underlying principles of plane geometry as applied to perspective, and he uses simple methods for explaining these principles so that they may be more readily comprehended. In treating the subject he assumes that the student is well grounded in plane geometry, and that a course in model-drawing is used in connection with the principles here set forth. Mr. Wilson first discusses and explains the terms used in connection with linear perspective, and then endeavors to fix the underlying principles so firmly in the mind of the student that he may dispense with actual construction and by an intelligent analysis of conditions, estimate the position of his guiding points sufficiently close for all practical purposes. Mr. Wilson, more fully than any preceding author, treats of the estimation of the perspective values of plane angles, and in Chapter VI. he explains to the draftsman the great importance of being able to sketch in onhand what he would have great difficulty in finding with perspective rules alone, and without some such facility he may not be able to obtain the exact conditions of the picture wished for. The author shows upon what the perspective value of a plane angle depends, and he then submits a classified group of conditions that furnish a key whereby the position of any plane angle can be established and its perspective value obtained. In succeeding chapters, he discusses changes of form due to changes of positions; tangent and intersecting planes; the phenomena of shadows; and sketches from working drawings. The book is arranged especially with a view to its use in schools and under each head are given illustrative examples and problems for solution.

ENGINE TESTS.—Embracing the Results of over One Hundred Feed-Water Tests and Other Investigations on Various Kinds of Steam Engines, Conducted by the Author. By Geo. H. Barrus, S. B., M. Am. Soc. M. E., etc. New York: D. Van Nostrand Co. Cloth; 8vo.; pp. 339. $4.00.

The author of this work has had an experience of 25 years in engine testing, chiefly among the mills in New England, and has accumulated a large fund of information in regard to the steam economy of the engines which have come under his observation. Much of this information he has compiled and arranged in this book. It contains quite full reports of tests of 60 engines of different kinds, some of them having been tested several times under different conditions, together with the diagrams obtained in each test. The information given in connection with each test includes not only the usual figures of dimensions, clearance, steam pressure, revolutions, horse-power and feed-water consumption, but other figures computed from the diagrams, such as pressures at cut-off and at release, back-pressure, at mid-stroke, proportion of stroke completed at cut-off, and proportion of steam accounted for at cut-off and at release. With the report on each engine tested there is given a page or so of discussion, explaining the conditions under which the test was made, and giving reasons, when any are apparent, for deviations from normal or expected economy. About two-thirds of the whole book is occupied with these reports. Besides them, the book contains a chapter on "How the Feed-Water Tests were Conducted," describing in detail the author's method of making tests; also a condensed summary of all the tests, arranged under headings of simple, compound and triple-expansion engines, a "Review of Feed-Water Tests," a chapter on Valve Setting, and one on Steam-pipe Diagrams. The "Review" discusses at length the subjects of cylinder condensation and leakage; effect of pressure upon economy; effect of speed upon economy; economy of condensing; effect of superheating; relative economy of simple, compound and triple-expansion engines; economy of steam-jacketing and reheating in compound engines; and effect of ratio of cylinder areas in compound engines. It is worthy of special note in view of recent discussions of the subject of cylinder ratios, that the author states that the engines with large ratios of cylinder areas, 7 to 1, show more economical results than the others with ratios of between 3.5 and 4 to 1. The average gain in economy in favor of the larger ratios is about 8%. The lowest feed-water consumption in the whole series of tests, 11.89 lbs. per I. HP. per hour, was obtained with a compound engine with large cylinder ratios, the figures for triple-expansion engines, only two of which were tested, being 12.71 and 12.55 lbs.. The chapter on valve-setting contains a large number of diagrams, some of which are curiosities, showing extremely bad results due to errors in setting.

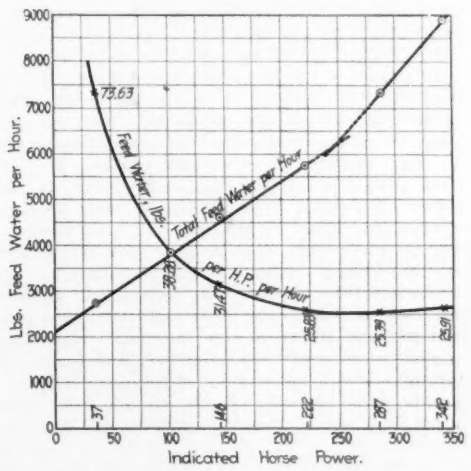
The discussion on cylinder condensation includes a plotted diagram of condensation and leakage for tight or fairly tight simple engines using ordinary saturated steam. The average curve drawn through the several observations shows the condensation and leakage to be about as follows for different percentages of cut-off:

Cut-off, % of stroke.....	2.5	10	15	20	25	30	35	42
Condens. and leakage, %.	60	43	35	29	24	20	17	15

The book is full of interesting information and will prove highly valuable to students of steam-engine practice. We note the omission of one table which the author might have given, viz., a table showing the comparative economy of engines of the single, double and four-valve types of the several classes. We have taken the trouble to compile a brief table of this kind, omitting the engines having "considerable leakage" and those greatly underloaded, as follows:

Tests of				Water per I.HP. per hour.	
16	simple engines,	non-condens'g,	4 valve...	25.4	to 32.7
2	" "	"	single valve..	33	to 36.3
12	" "	condensing,	4-valve....	18.25	to 23
2	compound engines,	non-cond'g,	4-valve...	21.6	and 22.1
5	" "	"	single valve.	21.1	to 25
23	" "	condensing,	4-valve.....	11.9	to 16.3
2	" "	"	single valve.	18.2	and 18.9

Another omission is a discussion of the total feed-water consumption at different loads. But few data on this subject are available in the records given, but engines Nos. 16, 31 and 54 were tested at different loads, and a plotting of the total feed-water consumption of these engines indicates a confirmation of Willans' law, viz., that the total consumption at different loads may be plotted in a straight line from zero load, showing cylinder condensation and leakage, to the most economical load. The test of engine No. 31, at six different loads, is especially instructive in this respect, since the four tests below the most economical load plot in nearly a straight line, as shown in the accompanying cut, and the two tests at overload may be plotted in a line of steeper ascent, which cuts the line through the four tests at a point corresponding to about 250 HP. and a water consumption of 6,250 lbs. or 25 lbs. per I. HP. per hour. This point is probably that of most economical load, and if this be so the diagram shows the feed-water consumption at zero load, viz., 2,125 lbs. per hour, to be 34% of the consumption at the most economical load.



Feed-water Consumption of a 4-valve (Corliss) Non-Condensing Engine at Different Loads. Two cylinders, each 16 × 42 ins.; steam pressure, 80 to 91 lbs.; revolutions per minute, 85 to 88.

THE AUTOMOBILE EXHIBITION AT MADISON SQUARE GARDEN, NEW YORK CITY.

The first annual exhibition of the Automobile Club of America was held at the Madison Square Garden, in New York city, during the week ending Nov. 10. Altogether the exhibition was a most creditable one. About 30 firms were represented by exhibits of complete vehicles, and nearly two-dozen others showed automobile parts, fittings, appliances and other accessories used in motor vehicle construction, and by the drivers and users of such vehicles. The attendance was large, and as a spectacle the arrangement of the exhibits and of the decorations was satisfactory. Perhaps the most noteworthy impressions to be received from the exhibition as a whole were: that the building of automobiles has become an industry of very considerable proportions, and that there was a remarkable absence of freak inventions. Another impression gained, which is, perhaps, worth mention, was that in an unusual number of cases the various types of motor vehicles shown had an astonishingly close resemblance to the same types of horse-drawn vehicles in use everywhere to-day.

For the purpose of more detailed description the exhibits may be divided into: (1) Steam vehicles; (2) gasoline vehicles; (3) electric vehicles, and (4) accessories. Numerically gasoline vehicles predominated, steam vehicles came next, and electric vehicles last.

STEAM VEHICLES.

SYDNEY B. BOWMAN CYCLE CO.—This New York concern made an exhibit of both steam and electric-propelled vehicles. The steam vehicle shown is a light run-about, with trussed axles, operated by a double cylinder, 3 × 3½-in. engine, working under a pressure of 140 lbs. The engine has a Stephenson link motion, and the eccentrics and all other rapidly moving parts are encased and run in oil. The engine has a chain drive to the rear axle. The boiler has a drawn copper shell and steel heads, and is provided with 325 copper tubes. Gasoline is the fuel used, six gallons being the quantity provided for. The air pressure for feeding the gasoline to the burners is provided by a power-pump and a pump operated from the crossheads is used to supply the boiler.

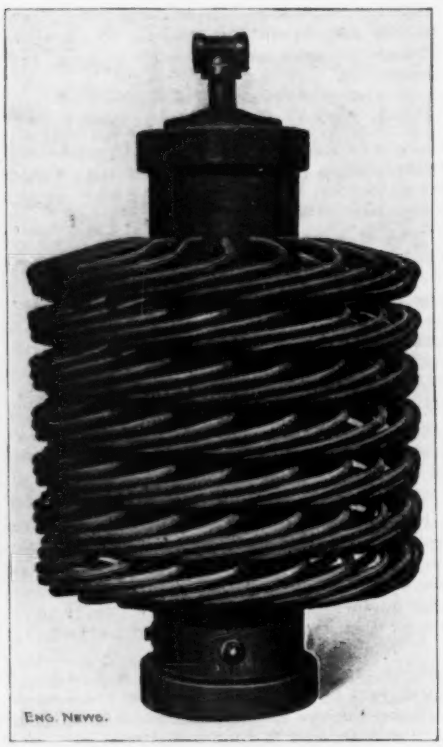
FOSTER AUTOMOBILE MFG. CO.—This Rochester, N. Y., firm exhibits several vehicles, including a run-about and a delivery wagon, the operating mechanism of all being essentially the same. The engines are of the double-cylinder, double-acting type, receiving steam from a standard vertical tubular boiler having from 298 to 356 tubes, and operating under a pressure of 225 lbs. The boiler feed pump is operated from the crosshead, and there is also an auxiliary hand pump. A hand air pump is used to supply the pressure for feeding the oil to the burners, which are regulated by hand from the driver's seat. The vehicle is mounted on suspension wheels.

LOCOMOBILE CO. OF AMERICA.—This New York city company had a large exhibit of pleasure carriages. Like the vehicles previously mentioned, the engine used is of the double-cylinder, double-acting type, with 2½ × 3½-in. cylinders, and Stephenson link. The boiler construction is novel in the fact that the copper shell is wound with two layers of piano wire. The boiler ends are steel, and there are 298 ½-in. copper tubes. The boiler carries a pressure of from 120 to 140 lbs., and blows off at 225 lbs. An automatic fuel supply regulator shuts off the fuel supply at 160 lbs. steam pressure.

MOBILE CO. OF AMERICA.—This company, whose works are located at Tarrytown-on-the-Hudson, N. Y., had a remarkably complete exhibit of pleasure vehicles, and also showed several delivery wagons, and a heavy army wagon built for carrying men and rations. The motive mechanism comprises the standard double-cylinder, double-acting engines, receiving steam from a vertical tubular boiler, and calls for no particular mention. One of the popular features of this company's exhibit was the running of one of its vehicles up a 45% grade. The fuel used is gasoline.

NEW YORK MOTOR VEHICLE CO.—The exhibit of this company was notable in the fact that it contained the largest and heaviest vehicle in the exhibition, an omnibus capable of seating 20 people. This vehicle is peculiar in having its running gear in two parts, one carrying the rear or driving wheels, and the other carrying the front or steering wheels. The wheels are of wood, with a steel felloe carrying a 4-in. solid tire. The axles are solid cold-drawn steel, and are fitted with roller bearings. The motive mechanism consists of a 4 × 5 × 7 × 5-in. double-acting compound engine, arranged with a by-pass to permit live steam to be turned into the low-pressure cylinder. This engine, which, with the boiler, is located nearly directly over the front wheels, has a chain drive to a countershaft located about midway of the vehicle. Two chain drives run from this countershaft to the rear wheels. The boiler used is a radical departure from the standard ver-

tical tube type. It is of the water tube type. Briefly described, it consists of a hollow drawn-steel core provided with some 900 exterior tubes arranged as shown below. This boiler has 400 sq. ft. of heating surface, and operates under a pressure of from 160 to 180 lbs. The boiler feed consists of



a siphon arrangement, and the feeding of the kerosene fuel to the burners is controlled automatically, being shut off when the boiler pressure reaches a certain amount. The boiler and engine can develop about 25 HP.

OVERMAN AUTOMOBILE CO.—The works of this company are at Chicopee, Mass. It exhibited a 750-lb. run-about, with steel tube frame, operated by a double-cylinder, double-acting, 2⅛ × 3-in. engine, receiving steam from a 400-tube steel boiler of the standard vertical tube type. A novelty in this vehicle is the exhaust arrangement. The steam passes through the running frame into a transverse tube located at the front and having numerous small orifices to dissipate the steam vapor. Steam is used up to 205 lbs. pressure, at which it blows off and forces more water into the boiler. An additional blow-off is provided for 215 lbs. pressure, and should the water run low the melting of a fusible plug extinguishes the burner. The boiler feed and fuel pressure are regulated automatically, but there are emergency hand appliances.

STANLEY MFG. CO.—This company, whose works are at Boston, Mass., showed two heavy vehicles, a stanhope and a delivery wagon, operated by a McKay compound engine, with a by-pass arrangement for throwing live steam into the low-pressure cylinder for heavy duty. This engine has 2½ × 3½ ins. × 4-in. stroke cylinders, and receives steam from a vertical tube boiler having a steel shell and copper tubes. There are 248 ½-in. tubes giving 44 sq. ft. of heating surface. Gasoline fuel is used.

STEAMOBILE CO.—Tihs company's works are located at Keene, N. H., and it exhibited a run-about of ordinary construction operated by a double-cylinder, double-acting engine receiving steam from an upright fire-tube boiler operating at 160 lbs. pressure. Automatic boiler feed and fuel supply pumps are used. The boiler feed pump is so devised that at high water a by-pass is opened allowing the pump, which acts continuously, to circulate the water back to the tank, while at low water it cuts off the fuel supply. Enough water and fuel are carried for a 75-mile run.

STEAM VEHICLE CO.—This Reading, Pa., company exhibited several vehicles, including a delivery wagon, all having steel tube frames and suspension wheels. The motive machinery consists of a double-cylinder, double-acting engine, taking steam from an upright fire-tube boiler of standard construction. The boiler is of steel, with 365 tubes, and has a capacity of 7 HP. Gasoline fuel is used.

SUMMARY.—A general summary of the preceding descriptions of steam vehicles brings out chiefly the fact that at present the standard steam vehicle motor equipment is an upright or vertical fire-tube boiler, and a double-cylinder, double-acting engine. Only two of the vehicles exhibited had a boiler of different construction, and only two had other types of engines, the engine in both these cases being compound, with a by-pass arrangement for turning live steam into the low-pressure cylinder. Of the two boilers which were not of the upright fire-tube type, one was the Climax boiler, already mentioned (Fig. 1), and one was the sectional water-tube boiler used on the single steam vehicle exhibited by the American Bicycle Co. This boiler consisted of eight sections of tubes staggered and interwinding with each other, and each section capable of being removed independent of the others. Automatic mechanical control of the boiler feed and fuel feed is nearly universal, but supplementary hand apparatus for both these purposes are usually provided. The operating steam pressure usually runs from 120 to 160 lbs., with blow-offs set at from 200 to 225 lbs.

GASOLINE VEHICLES.

Of the 30 firms exhibiting complete vehicles, 16 firms showed gasoline vehicles. The Autocar Co., of Ardmore, Pa., exhibited three vehicles in which the cylinders of the two-cylinder gasoline motor were placed on the opposite sides of a longitudinal shaft, at right angles to the driving shaft. The vehicles shown by the Canda Mfg. Co., of Carteret, N. J., also had their motor shafts arranged at right angles to the driving shafts. The De Dion-Bouton Motorette Co., of Brooklyn, N. Y., presented a meritorious novelty in their practice of attaching the entire steering and motor mechanism to the running gear, so that this part of the vehicle forms a separate and independent unit to which any form of body may be applied. Speaking more generally, the most commonly used motors are the De Dion and the Otto. Generally change speed gears are employed, and these are arranged in a great variety of ways, each maker having some special wrinkle of his own upon which he based a claim of superiority for one reason or another. In cylinder cooling the almost universal practice is to use water, but the Knox Automobile Co., of Springfield, Mass., exhibit an air-cooled motor of special construction. Another novelty in this direction is the arrangement of the Daimler Mfg. Co., of Long Island City, N. Y., by which a fan on the motor shaft forces a current of air through the tubes of the water tank to keep it cool. The names of the companies exhibiting gasoline vehicles, in addition to those mentioned, were: Automobile Co. of America; Duryea Motor Co., Reading, Pa.; International Motor Carriage Co., Stamford, Conn.; Ohio Automobile Co., Warren, O.; Peerless Mfg. Co., Cleveland, O.; John T. Robinson & Co, Hyde Park, Mass; St. Louis Motor Carriage Co., St. Louis, Mo.; Springfield Cornice Works, Springfield, Mass.; Upton Machine Co., New York city; Winton Motor Carriage Co., Cleveland, O., and Waltham Mfg. Co., Waltham, Mass.

ELECTRIC VEHICLES.

BAKER MOTOR VEHICLE CO.—This Cleveland, O., firm showed a remarkably light run-about, its weight being only 530 lbs. The running gear consisted of a steel tube frame and suspension wheels. The battery used consisted of ten cells, and the motor was a double-wound machine operating at 4,000 revolutions per minute. A chain drive runs from the reducing gear to the rear axle. The controller has knife-switch contacts, and two variations of speed are secured by throwing the controller handle forward into two positions. For reversing the machine there is an interlocked reverse switch, which prevents the reversing of the controller handle without stopping at the cut-off point.

NATIONAL AUTOMOBILE & ELECTRIC CO.—This Indianapolis, Ind., firm exhibited a variety of vehicles, including a light run-about and a heavy dray. In the lighter vehicles the motors are hung over the rear axle, and in the heavier vehicles they are hung from the reach. A special feature of the mechanism is a combination emergency switch, lock switch and electric brake operated by the same lever. In all but the very light vehicles wooden wheels are used.

RIKER MOTOR VEHICLE CO.—This firm, whose works are at Elizabeth, N. J., had a very large exhibit, including notably a 20-passenger omnibus and a 5-ton truck, with several lighter trucks, delivery wagons, and omnibuses. The double motors used are attached to the rear axle and braced to the reach; and have a compensating gear. They are enclosed in water-proof and dust-proof cases. Generally the batteries are arranged in groups, and variations in speed are obtained by varying the coupling of the different groups. Each driving wheel is provided with a brake.

WOODS MOTOR VEHICLE CO.—This Chicago firm showed a veriety of machines, including a brougham and hansom cab, all very handsomely finished. Double motor drive is employed, the motors being braced to the reach and supported over the rear axle. The motors are series wound, and variations of speed from 6 to 22 miles per hour are secured by varying the connections of the motor. Generally 40-cell batteries of the Willard or Helios-Upton type are used.

ELECTRIC VEHICLE CO.—This company exhibited 18 vehicles of the "Columbia" type, including run-abouts, broughams, hansoms, omnibuses, and delivery wagons. In all cases a double motor equipment is provided, the motors being supported on the rear axle. The controllers are of the Lewis parallel type, and are located under the driver's seat. In the heavier vehicles the battery is hung under the body, but in the lighter vehicles they are within the body.

A NEW SPEED-CHANGING GEAR.

The value of a power transmitting device, which while receiving power at a constant rate would be able to overcome a varying resistance, has long been recognized. All speed changing gears heretofore devised, however, have been complicated affairs. Most of them have transmitted the power through rolling contacts or by belts operating upon conical pulleys, and such devices are not reliable in operation and soon wear out.

The speed-changing gear that we are about to describe is positive in its action, comparatively simple in its construction and it may be so arranged as to operate automatically. We will begin our description by explaining the principles upon which it works.

Imagine a driving shaft and a driven shaft which lie in the same line, that is, they are concentric. Between their adjoining ends place a disk, supported by a bearing on its periphery in such a way that the center of the disk may be held concentric to the shafts or may be moved to an eccentric position. Now, upon the driving shaft mount three arms, each of which is free to turn loosely on the shaft in one direction, but is prevented by a pawl and ratchet, cam clutch or other similar device from turning in the opposite direction. Each of these arms is to be provided with a radial slot fitting over a pin on the intermediate disk. The three pins on the disk are parallel to its axis, and are fixed equiangularly upon its circumference.

Supposing now that the disk is concentric with the driving shaft and that the latter is turned in such a direction that the clutches take hold, the disk will be carried around at the same rate as the shaft. What happens when the disk is moved to an eccentric position can best be shown by a diagram.

Referring to Fig. 1, O is the center of the driving shaft, which is turning at a uniform rate in the direction indicated by the arrow. Upon it are mounted the three arms l m n engaging the three

pins r a p upon the intermediate disk, whose center is at X. Now it will be evident that while m, for instance, is moving through the angle A O B r will move through the arc corresponding to the angle A X B, which is greater than A O B. Hence, the disk will move with a higher rate of rotation than the driving shaft. In the positions shown the pawls of n and l will not engage, since those arms are being dragged around by the disk at a speed higher than that of the shaft.

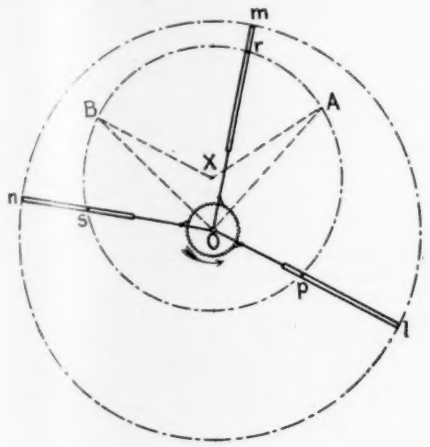


Fig. 1.

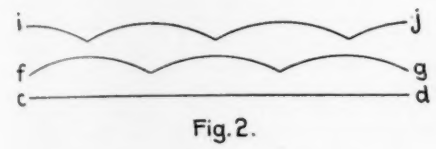


Fig. 2.

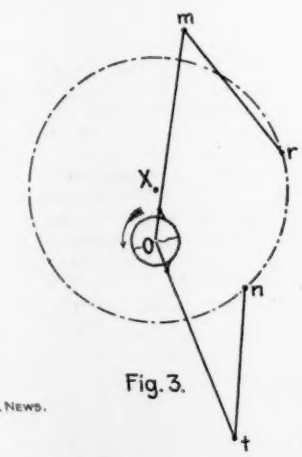


Fig. 3.

ENG. NEWS.

Figs. 1, 2 and 3.—Diagrams Explaining the Dieterich Variable Power-Transmitting Gear.

The second or driven shaft is provided with three arms similar in all respects to l, m and n, except that their pawls point in the opposite direction. Their slots engage three pins upon the side of the disk. What will happen to the driven shaft when the intermediate disk rotates may be understood by imagining the disk in Fig. 1 to rotate backwards. The clutching will take place upon the lower side of the shaft and the shaft will be driven at a rate of speed higher than that of the disk. It will thus be seen that in normal operation, when the disk is eccentric to the shafts, the disk will rotate faster than the driving shaft and that it will drive the second shaft at a still higher rate. It will be noticed that while the speed of the disk is higher than that of the driving shaft, it is not uniform even when the speed of the latter is so. If in Fig. 2 we represent the uniform speed of the driving shaft by the straight line c d, the motion of the disk will be represented by the wavy line f g, the interval from f to g being a whole revolution of the disk. Likewise, if the disk were to rotate at a uniform speed, the motion of the driven shaft would be represented by the wavy line i j. By rightly proportioning the parts of the mechanism and placing the pins on the two sides of the disk at the proper angles from each other, the irregularities may be balanced one against the other, and then when the driving shaft is moving at a uniform speed the driven shaft will also move at an approximately uniform but higher speed. When the disk is concentric with the shafts all three will turn in synchronism. The ratio of transformation, then, may be varied from unity to any value permitted by the proportions of the parts of the apparatus.

Having now explained how the speed ratio may be varied by this device, we will show how it may be made to change automatically, according to the character of the load. Replace the pin and slot connection by a toggle joint, as in Fig. 3, and suppose the center X of the disk constrained to move in a straight line passing through O. It will be seen then that, with the direction of rotation as shown, the arm m, which is supposed to be attached to the driving shaft, will have a tendency to drag by the link connecting it to the pin r the intermediate disk to a position of greater eccentricity, and that this tendency will be the greater the nearer the disk is to concentricity. On the other hand, the arm t, which is supposed to be attached to the driven shaft, will have a tendency to drag the disk back to concentricity, and that tendency will be the greater the farther the disk is from concentricity. That is, if the load is light, the influence of the arm m will predominate, the disk will be dragged outwards and the ratio of speed transformation will be increased. But when the load is heavy the influence of the arm t will predominate and the disk will be brought towards concentricity, or the position of unit speed ratio. For intermediate loads it will take up some intermediate position.

Thus we may suppose this gear to be included in the power transmitting parts of a bicycle. When going on a good and level road the disk would be at a position giving a high speed ratio, but as soon as a hill or heavy road were encountered the disk would move back towards the center and the rider would be able to continue pedalling at the same rate and exerting the same force as before, although his speed would be slower. In the same way the device could be applied to a motor vehicle driven by a gasoline or other motor. It may be noted, also, that provision may be made for locking the disk in any desired position, thus fixing the ratio of transformation.

The inventor of this device, Mr. L. M. Dieterich, of Hartford, Conn., has constructed a number of models and has equipped three or four bicycles to operate with automatically variable power-transmission. The variable-ratio gear of one of these is shown in Fig. 4. The entire mechanism is contained within the hub of the rear wheel. At 1 is the rear sprocket, which is attached firmly to the cup-shaped part 2. The latter drives by roller clutches, one of which is shown at 3, three rings. Fig. 5 shows one of these rings by itself. Each ring is connected by a link to the part 4, which is shown more plainly by itself in Fig. 6. This is in turn connected by three links to three rings on the right-hand side. These grip by roller clutches with the part 8, which is rigidly connected to the hub of the wheel.

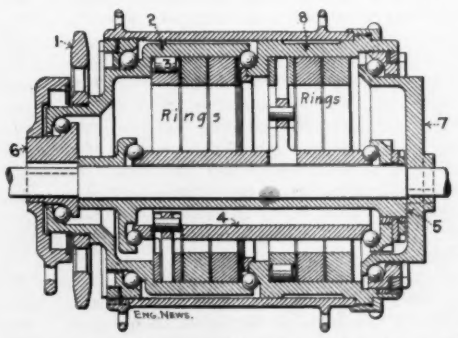


Fig. 4.—Longitudinal Section of Bicycle Hub Provided with Dieterich Gear. (Half Size.)

To make this clearer, according to our phraseology above, 1 is the driving shaft, the rings take the place of the driving and driven arms, 4 is the intermediate disk to which the latter are connected by links and 8 is the driven shaft. The part 4 is so mounted that it may be shifted nearer to or farther from concentricity. This may be allowed to take place automatically, or it may be done by the rider from his seat. It is accomplished by the partial rotation of the part 5 about the shaft with respect to the parts 6 and 7. In order that this may be done by the rider, a projection on 5 extends through a circular slot in 7 concentric with the shaft; 7 is shown in detail in Fig. 7.

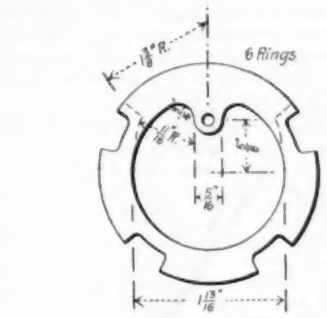


Fig. 5.

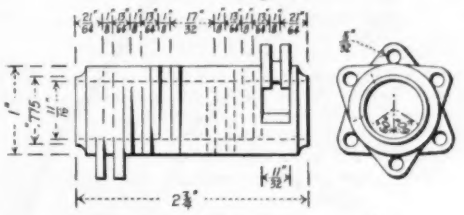


Fig. 6.

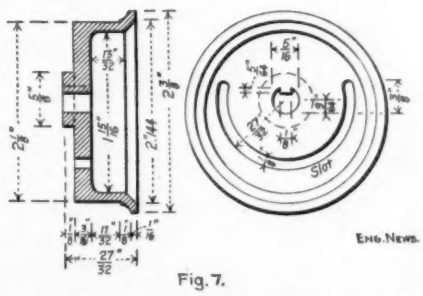


Fig. 7.

Figs. 5, 6 and 7.—Details from Fig. 4. (Half Size.)

For certain purposes, as for driving a lathe, it may be advantageous to dispense with the toggle joints on one side of the intermediate disk and to counteract the pull of the other set of toggles by a spring.

For the material used in preparing this article we are indebted to Mr. Dieterich. The invention, known as the Dieterich gear, is controlled and is being placed upon the market by the Dieterich Gear Co., of Hartford, Conn.

THE PNEUMATIC CAISSON FOUNDATIONS FOR THE BROAD-EXCHANGE BUILDING, NEW YORK CITY.

(With two-page plate.)

The Broad-Exchange Building, now under construction at the corner of Broad St. and Exchange Place, in New York city, will be the largest office building in the United States. It will be 23 stories, or 286 ft., high above the street and will cover an irregular area of about 27,000 sq. ft., with frontages of 236 ft. on Exchange Place and of 106⅞ ft. on Broad St, and with a wing about 100 ft. long and 35 ft. wide extending south toward Beaver St. The exact dimensions of the ground plan are shown by Fig. 1. Altogether there will be 10,000 tons of steel employed in the framework, which will be inclosed with walls of granite to the top of the first story, of Indiana limestone to the top of the third story, and of brick and terra cotta for the remainder of the height. The framework will be carried by 100 lines of columns, each founded on a separate steel caisson sunk either to bedrock or to the hardpan overlying it. The large number

of caissons which were sunk and the extreme celerity with which, under the conditions, this work was done, make the foundation construction of particular interest, and we present here a description of the apparatus and methods of work employed. In a future issue we shall endeavor to give similar details of the steel frame construction.

PRELIMINARY WORK.

The foundation work of the Broad-Exchange Building is of interest, not so much for its character, which was not particularly novel, as it is for its extent and for the difficulties which resulted from the short time available for carrying it out. To make these matters clear it is necessary to set forth the actual conditions in some detail.

The Broad-Exchange Building is being built for a syndicate of New York capitalists, the general contractors being the George A. Fuller Co., of New York city. The contract called for the completion of the building ready for the tenants by May 1, 1901. On May 1, 1900, the work was placed in the hands of Clinton & Russell, of New York city, as architects, and of Purdy & Henderson, of New York city, as structural engineeers. So far as actual construction was concerned, therefore, the condition of affairs was that, not a line of the plans had been placed on paper twelve months previous to the day set for the tenants to move into the building. Evidently the utmost haste was imperative. Furthermore, it must be remembered that this haste was necessary at a time when the rush of work had placed all of the large steel mills behindhand with their orders, and that large quantities of steel work were the first materials needed for the beginning of construction.

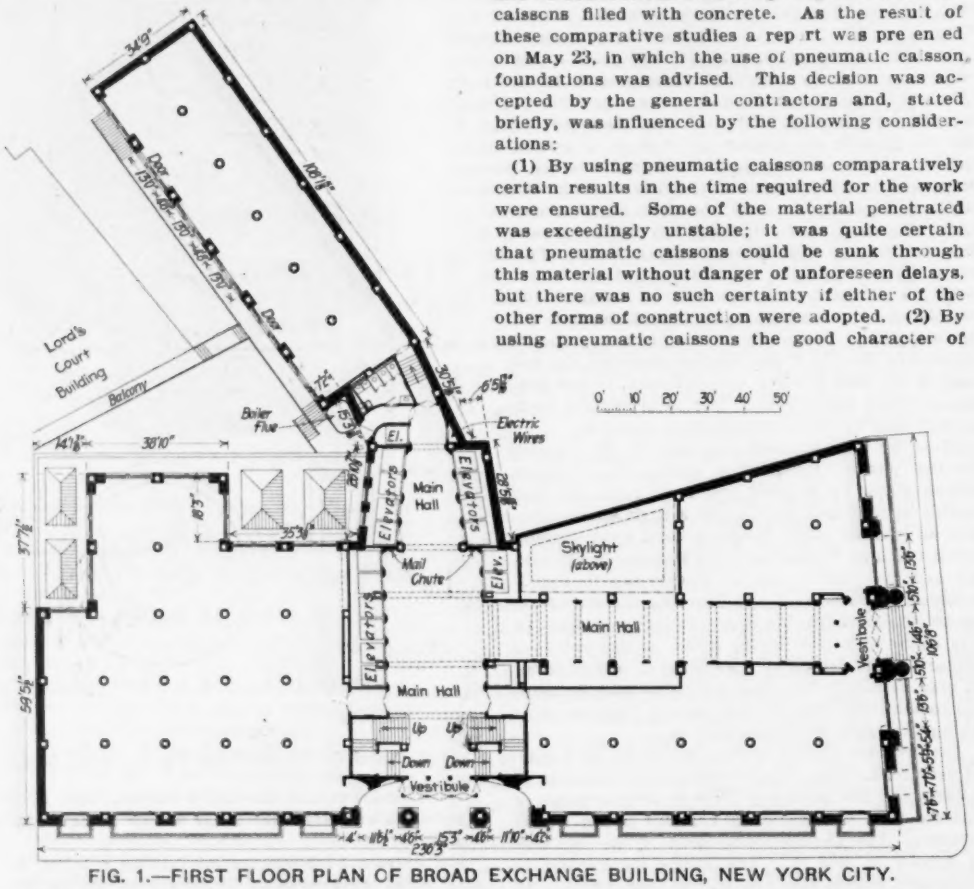


FIG. 1.—FIRST FLOOR PLAN OF BROAD EXCHANGE BUILDING, NEW YORK CITY.
Clinton & Russell, New York City, Architects. Purdy & Henderson, New York City, Engineers.

The problem was a twofold one: plans had to be prepared in a remarkably short time, and methods had to be devised to secure the manufactured materials to put these plans into material form in the building. Under ordinary conditions the engineers would have waited until the architects had settled upon at least the general layout of the building before beginning work, but to follow this precedent in this instance would have necessitated a delay which, although it was short, neither they nor the architects were disposed to endure patiently. Accordingly the engineering studies were begun without knowing at all what the final plans of the architects would be. It is obvious that these studies had to be in a great measure of a tentative character.

The first act was to adopt a tentative plan calling for 106 lines of columns, and to estimate and assume the column loads. This work gave something of a definite basis upon which to begin studies of a foundation plan. The general contractors had had in mind using pile foundations, but before adopting this construction it was decided to make a comparative study of several types of construction. The next work, therefore, was to design and to estimate the costs and relative advantages of pile foundations, foundations consisting of steel cylinders filled with concrete and of foundations consisting of pneumatic steel caissons filled with concrete. As the result of these comparative studies a report was presented on May 23, in which the use of pneumatic caisson foundations was advised. This decision was accepted by the general contractors and, stated briefly, was influenced by the following considerations:

(1) By using pneumatic caissons comparatively certain results in the time required for the work were ensured. Some of the material penetrated was exceedingly unstable; it was quite certain that pneumatic caissons could be sunk through this material without danger of unforeseen delays, but there was no such certainty if either of the other forms of construction were adopted. (2) By using pneumatic caissons the good character of the foundation work could be ensured beyond a doubt, and this was not possible if either of the other constructions was employed. (3) The reputation of pneumatic caisson foundations for excellency was considered to be a material advantage to the builders and owners from a business standpoint. There was also another consideration which influenced the selection of pneumatic caissons, and this was that whatever style of foundation might be adopted for the other columns, those coming on the party lines would have to be founded on pneumatic caissons in order to prevent disturbing the foundations of the adjacent buildings.

With the consent of the general contractors to this use of pneumatic caisson foundations one factor of the problem had been disposed of. By this time the architects had determined in a general way the lay-out of the building, and it was possible to decide approximately upon the number of columns to be employed. It was not possible, however, to locate these columns definitely, and hence their exact loading could not be calculated. From the data available, however, two things were certain: (1) that the number of columns to be provided with foundations would be at least 100, and (2) that the loads on these columns would run between a certain maximum and minimum. Obviously, therefore, if a typical caisson should be designed which could be made in a number of sizes between those required for the known maximum and minimum loads, it would be possible to order a number of each size in advance of definite knowledge where each was to be located and yet with the certainty that they could all be used somewhere. There was very little risk in such a mode of procedure, and the gain in time of manufacture which it made possible was an important advantage.

The column caissons were, therefore, divided into two classes. The first class comprised the cassions for the wall columns on the party lines, which required special design in each instance, and could not, therefore, be designed until the location and loading of the columns which they were to carry were definitely known. The second class comprised all but a few of the columns not coming on party lines and for which a typical general design of caisson was possible. The typical design of caisson adopted was a cylindrical caisson of steel; the diameters were fixed at 7, 7½, 8, 8½, 9 and 9½ ft. The next step was to secure some one who would manufacture these steel caissons quickly. To obtain immediate manufacture and delivery by any of the large steel works was found to be out of the question, and a search was begun among the smaller concerns capable of handling the work. This search proved unusually successful. A contract was made with the Lukens Rolling Mill Co., of Coatesville, Pa., to roll the steel sheets in three days, and with the Coatesville Boiler Works to begin the delivery of the caissons in ten days from the date that the steel sheets were delivered to them, providing they were furnished the I-beam bracing, which they could not manufacture, at once and in shape ready for use. To secure the I-beam bracing the engineers went to a number of places wherever a small lot could be obtained, and to ensure its prompt delivery to the Coatesville Boiler Co. a man was sent on the car with every lot to prevent any hold-up of the shipment by the railways.

Shortly after the order for the manufacture of the caissons had been given, the architects presented a definite plan of the building. This plan enabled the engineers to begin the definite design of the steel work, and the plans were far enough advanced by the time the first delivery of caissons was made, to enable them to be located at once, and the sinking begun. Before describing the work of sinking the caissons, the general character of the foundation construction and the details of the caisson construction will be described and illustrated.

GENERAL PLAN OF FOUNDATIONS.

The foundations were designed upon the general plan that each line of columns should have its individual caisson foundation. The plan as worked out is shown by Fig. 2. All the caissons except those located along a portion of the south and west party lines are cylindrical and carry the column footings concentric with their top. The party wall caissons are rectangular with their longer sides parallel to the party line. As will be seen the cylindrical caissons vary from 7 ft. to 9½ ft. in diameter, the greater number being of the smaller size. They are filled with concrete to the top, and most of them also have a granite capping the full size of the caisson. The column bases are circular in plan and are bolted directly to the caisson masonry.

In the case of the rectangular caissons the column loads are distributed to the masonry by means of I-beam grillages, as shown by the various sectional elevations of Fig. 2. The most complicated of these distributing girder systems is that for the group of columns at the south end of the wing, an enlarged plan of which is shown by Fig. 3. A sectional elevation of this system is shown by Fig. 2. The two bays or panels between columns Nos. 78, 79 and 80, have a system of wind bracing consisting of X-braces of channels.

CAISSON CONSTRUCTION.

Details of the caissons are shown by Figs. 4 and 5. Fig. 4 shows one of the 7-ft. cylindrical caissons, but the construction of those of larger diameter is practically the same. Fig. 5 shows

one of the rectangular caissons; the others, except one, No. 98, which is of trapizoidal form, are exactly like this except in dimensions. All the caissons were built of medium steel 5-16-in. thick for the caisson proper and ¼-in. thick for the cofferdam portion. The caissons all have reinforced cutting edges and a working chamber 6 ft. 6 ins. high. The minor details of construction are clearly shown by the drawings.

METHODS OF WORK.

Borings made at ten different points over the foundation area showed first a layer of filling from 2 ft. to 6 ft. thick overlying a layer of fine sand or fine sand and clay mixed, which extended to hard-pan at an average depth of about 40 ft. below the street surface. The fine sand and clay mixed proved to be a very unstable material; when wet it ran almost as freely as water. The hard-pan was, however, of the firmest and most stable character, being practically a rock, and directly below it came the gneiss bedrock. Upon the showing made by the borings general instructions were drawn for the sinking of the caissons, which were, somewhat condensed, as follows:

If the hard-pan over the rock is not more than 6 ft. deep, the shaft should be open to the bottom and cleaned out so that the concrete shall have a perfect bearing on the clean rock. If the rock is not more than about 1 ft. out of level and the hard-pan is about 2 ft. thick or more, the concrete can be placed directly on the rock. If the hard-pan is thin or there is none, and the face of the rock is generally even, it must be leveled off or cut or shaped in some way so that it will resist any tendency to lateral displacement. If the rock is very uneven it must be leveled off or channeled or fixed in some good way to afford a satisfactory footing for the concrete shaft, not only for the direct load it must carry, but also to resist any tendency to lateral displacement.

If rock is not found after the excavation has been carried fully 4 ft. into good hard-pan, drive a crowbar, in not less than two places, to locate the rock. If it is found within 2 ft., excavate out the hard-pan to a secure bearing on the rock. If it is not found, clean out a footing on the hard-pan over an area somewhat larger on all sides than the size of the cutting edge of the caisson, as given in the schedule below:

7-ft.	diameter	must	be	excavated	8	ins.	more	all	sides.
7½-ft.	"	"	"	"	8	"	"	"	"
8-ft.	"	"	"	"	9	"	"	"	"
8½-ft.	"	"	"	"	10	"	"	"	"
9-ft.	"	"	"	"	11	"	"	"	"
9½-ft.	"	"	"	"	12	"	"	"	"

By this schedule of enlargement the bearing area of the caisson masonry was increased from 39% for the 7½-ft. caissons to 49% for the 9½-ft. caissons.

The contract for the pneumatic work in sinking the caissons was awarded to the Engineering Contract Co., of New York city. The general contractors located the caissons, set them up ready for sinking, furnished the concrete, and supplied the derricks and hoisting machinery; the Engineering Contract Co. furnished the compressed air, the steam power and the labor, and sunk the caissons and placed the concrete under pressure. The concreting in the open was done by the general contractors. The engineers checked the location of the caissons and watched that they were kept plumb. Their engineer in charge also went into each caisson to see that the excavation had been properly finished and also supervised the placing of the concrete. With this brief explanation of the apportionment of the work, it will be described as a single task to avoid confusion.

The bottom of the foundation excavation was about 15 ft. below the street surface, and at the level of the street surface a strong timber platform was built covering the whole area. The caissons and all structural material for the foundations were unloaded onto this platform and it also carried the power plant and machinery. Chutes, stairways and traps at various points in the platform allowed the materials to be sent below as they were needed.

The air compressor plant for the caisson work consisted of two 16-24 × 12-18-in. Ingersoll-Sergeant air compressors, supplied with steam by a 4-in. pipe from the mains of the New York Steam Co. These compressors delivered into a 6 × 18-ft. cylindrical receiver. To cool the compressed air for delivery to the caissons two methods were employed. When at the beginning of the work no more than four caissons were being sunk at once, it was found possible to keep the air below 80° F. by pumping cold water through the receiver. At a later stage of the work when as many as ten caissons were under way at once an additional cooling device was employed which consisted of 54 pipes ¾-in. in diameter contained in an 18-in. × 15-ft. cylinder. The air from the compressors was passed through the pipes and cold water was kept in constant circulation through the cylinder. From the cooling cylinder the air passed into the receiver at a temperature of about 70° F.

For the first five or six feet of their descent or to water level the excavation inside the caissons was done in the open, and then air pressure was put on. As the sinking progressed the cofferdam of the caisson was added to so as to be always above water level, and was filled with concrete around the central air shaft. The maximum air pressure used was 18 lbs. Generally the weight of the concrete in the cofferdam and a load of ten or twelve tons of pig iron were sufficient to sink the caissons. The caisson men worked in three shifts of eight hours each, and there were nine gangs of six men in each shift. Each gang had three men in the working chamber, one man in the air lock and two outside. Air pressure was maintained at 30 lbs. in the receiver and was throttled down to the required pressure at each caisson.

All the caissons were provided with 36-in. shafts, which in the majority of cases were divided diametrically by two inside angle guides. The bucket used was semicircular in plan and worked up and down in one compartment of the shaft while the other compartment contained a ladder and served as a man shaft. In other cases a cylindrical bucket 18 ins. in diameter was employed.

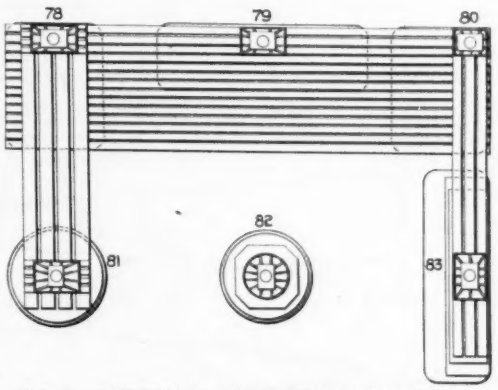


FIG. 3.—SKETCH PLAN OF EQUALIZING GIRDER SYSTEM FOR COLUMNS 78, 79 AND 80.

At first the concrete was mixed on the main platform near the caisson in which it was to be used. Later on two small platforms were built at central points about 10 ft. or 12 ft. above the main platform and each of them was equipped with a balanced wheelbarrow-elevator running to the bottom of the main excavation. The cement, sand and broken stone were hoisted to the upper platform and mixed by hand. The mixture was then shoveled into a gravity mixer which discharged onto the floor of the main platform. From the point of discharge the concrete was taken by wheelbarrows to the caissons. Pressure was maintained in the working chamber until the concrete was set, and then the air lock was removed and the cofferdam was filled and the capstone placed. The final work was the placing of the column pedestals. Figs. 6, 7 and 8 show details of typical pedestals.

In conclusion it should be noted that 88 caissons were sunk in 47 days. The most rapid sinking recorded was 2 ft. in one hour and 27 ft. in 20 hours.

COMMITTEE REPORTS AT THE ANNUAL MEETING OF THE ROADMASTERS' ASSOCIATION OF AMERICA.

We give below abstracts of some of the reports presented at the above meeting, which was held at Los Angeles, Cal., Nov. 13 to 15:

REVERSING ALTERNATE BOLTS IN RAIL JOINTS.

The office of the track bolt is to hold the angle bars rigidly in place, supporting the rails and maintaining them in surface and line. A study of the varying conditions and requirements will show that there are excellent reasons why the joints should not be held by bolts placed with heads all on either outside or inside of the rail. Where heads are all on one side of the rail, the shoulders on bolts in slots in the angle bars throw on one angle bar a large proportion of the strain caused by expansion and contraction of the rails, and the result is frequently breaking of the bolts, and the crowding of the joint out of line. By reversing half the bolts, the strain is equalized between the two angle bars, and there is less liability of the breaking of bolts, and joints will be more easily maintained in true gage. The staggering of the slots for spikes in angle bars makes it impossible to avoid placing some of the slots so nearly under the bolt holes that when a nut is placed over such a slot, it is impossible to drive or pull the spike without removing the bolt. By alternating or staggering the bolts, it can be done in such a manner that the head, instead of the nut, will be placed over such slots, and the head will be found not to interfere with the driving or pulling of spikes. The advantage gained by this manner of bolting is particularly noticeable when spacing joint ties under rail newly laid, much time being saved in spiking.

By far the weightier reasons, however, for staggering bolts at joints is that it reduces very materially the liability of excessive damage in case of derailment. Frequently only one pair of wheels may be derailed, in which case the wheels striking the nuts, will shear every bolt for long distances. When the rails remain in line and gage but little damage may result, but should they become displaced sufficiently to derail following cars, the most disastrous results are almost certain to ensue. A derailed wheel will not shear the heads of bolts, and if the bolts at joints are staggered, all the bolts cannot be destroyed. The writer would recommend the adoption of a resolution recommending the alternating or staggering of bolts at joints on all rails of sufficient height to allow nuts on bolts inside the rail to clear the flange of wheel.

Gurdon W. Merrell.

THE BEST METHODS OF HANDLING BALLAST.

The best method of handling ballast, of whatever kind, depends very much under what conditions and in what localities the work is done and it depends also on the price of labor. For handling stone from the quarry to the crusher and from the crusher to the railway cars, elevators or conveyors, or dump cars run by cable or gravity are used. Gravel is best loaded in quantities by a steam shovel, as also slag cinders, burned clay, or vegetable soil. Cost of loading gravel by steam shovel varies from about 4 cts. per yd. upward, depending on amount of track work to be done, height and length of bank, switching facilities, time lost waiting for empties and interruptions to the work on account of break-downs or moving back of steam shovel for a fresh cut, also on account of stripping to be done. Flat, dump or hopper-bottom cars should be used for ballasting, the flat cars being best unloaded with a plow hauled either by the locomotive, or by a special hauling engine made for the purpose which winds the cable as it is drawn in. Flat cars should be provided with aprons to prevent the ballast from being dumped between the cars and having to be shoveled out by hand, causing delays and extra expense of handling. The flat cars should also be provided with removable sides; preferably these should be chained or hinged to the car to prevent them from being thrown on the ground to be damaged and save the time of picking them up.

Track should be raised to grade stakes and lined to center stakes. The best way to ballast track is to have the track raised to the full height, the ties shovel tamped about 18 ins. under the rails and the ballast loosely filled in. This method saves a lot of work, as the movement of the trains over the track causes the loose ballast to work in under the ties; from 100 to 125 ft. of track per day should be raised per man. The track should then be lined. After a day or two, the track should be surfaced carefully and all ties tamped with tamping picks or bars. This work should be followed up by a gang who will line out any kinks and trim and dress the gravel to the required section. This gang should be provided with templets and lines so that the finished ballasting will be uniform throughout. The cost of raising track and finishing with gravel varies from $450 to $575 per mile, and with crushed rock about $900 per mile.

Walter E. Emery, C. F. Blue, Chas. McEniry.

USE OF TIE PLUGS IN HARD AND SOFT WOOD TIES.

Your committee has made several tests under the different conditions with hard and soft wood ties with the different kinds of track spikes having pointed many spikes in different ways to better determine the kind that would less bunch or disturb the fiber of the different kinds of wood, and the pressure required to withdraw the spikes from ties of different kinds of timber in which some had been driven in a new place, while others were driven through the tie plugs.

(1) Every spike hole left unplugged fills with water after the first rain, and remains there to soften and rot the tie; where a spike is withdrawn for any purpose the hole should be plugged and spike redriven in the same place, when practical to do so without weakening the tie

by putting in a new place and cutting off more of the fiber of the tie.

(2) A spike driven in the tie plug, more particularly in soft wood ties, holds with more than double the adhesive force with which it held when first driven; the advantage of driving the spike into the tie plug results from the fact that when a spike is driven into a tie it must displace and carry down with it a sufficient quantity of fiber to allow the body of the spike to be partly unsupported, whereas when driven into the plug it enters lengthwise of the grain of the plug and simply compresses the fiber of the plug against the walls of the spike hole.

(3) Experience has demonstrated that the best kind of timber from which tie plugs should be made is second growth elm, white oak, and ash, in the order in which they are mentioned; cedar and pine are totally unfit for tie plugs, the timber being too weak and brittle to stand the impact of the blows necessary to drive them home, so that they will break off when only partly driven. This is a very serious defect, because while it may plug the hole against water, if the spike should be driven into it, it will go partly down with it, and thus leave the spike unbraced either at its neck or at its point. The tie plug, therefore, should be of sound, hard, tough timber to secure the best results. Elm has the preference over oak, because when pressure and friction are applied to elm it develops a rough surface, whereas where the same forces are applied to oak it develops a smooth, slippery surface. Oak is also heavier and more costly. Ash is but very little different from oak as far as its qualities are concerned. T. Hickey, G. M. Brown, T. S. Cafferty, J. W. Meredith, H. Ferguson, P. W. McKeon.

CHEMICAL TREATMENT OF CROSS TIES.*

The chemical treatment of cross ties, as has been said in our conventions before, is the work of a chemist and not of a roadmaster, and I will therefore be very brief with reference to this matter. The A., T. & S. F. Ry. was the first of the western roads to go into this subject. This was in 1885, 15 years ago, and I have reports showing that some of these ties are still in the track, which is certainly a remarkable record, considering that the ties that were treated were mountain pine of New Mexico, the average life of which without treating is about four years.

We generally let the ties season about six months, they are then run into long cylinders, then the doors are closed and the timbers steamed from two to three hours to get out of the natural sap, which generally takes from two to three hours. Then the condensation is drawn off and a vacuum pump put on. Then the chlorides of zinc is let in, and a pressure applied of about 100 lbs. per sq. in. This pressure is maintained about three hours. The absorption is about 2% of chloride of zinc. All the solution

Fig. 1.—View of a Portion of the Revere Beach "Centrifugal" Railway, Showing "Loop."

not then taken up by the wood is then pumped back into the vats, and the glue and tannin solution is then applied. The glue and tannin seal the ends of the ties and keep the zinc solution in the grain of the wood. We find that all the solution is got into the wood lengthwise with the grain, and not from the sides. The glue and tannin prevent the rain and dampness leaching out the chloride of zinc. We consider this Wellhouse process much better than the burnetizing method, which consists simply of chloride of zinc.

*Abstract of a paper presented by J. M. Meade, Resident Engineer, A., T. & S. F. Ry., Topeka, Kan.

During the years 1898 and 1899 very close figures were kept as to the cost of treating ties at the Las Vegas plant, which was as follows:

	1898.	1899.
Chemicals	$0.1097	$0.1211
Labor	.0250	.0226
Fuel and supplies	.0031	.0033
Total cost per tie, f. o. b.	$0.1378	$0.1470
Absorption of zinc per cu. ft.	0.518%	0.523%

You will see from these figures that the average cost of treating for two years above-mentioned was $0.1424 per tie, or practically 14½ cts. per tie f. o. b.

The Santa Fe now have three large plants established —one on the Gulf, Colorado & Santa Fe, at Somerville, Tex., with a daily capacity of about 6,500 ties; one at Las Vegas, N. Mex., with a daily capacity of about 2,500 ties, and one at Belemont, Ariz., with a daily capacity of about 2,100 ties.

I understand that the Southern Pacific has gone quite extensively into this method of preserving ties. I believe they started their plant in 1887 and have over 800 miles between Houston and El Paso largely laid with treated ties, and I understand from a report received from their engineer, Mr. J. T. Mahl, that they have had very gratifying results since they commenced using them.*

A "CENTRIFUGAL" RAILWAY FOR PLEASURE RESORTS.

By M. F. Brown.†

In the issue of Engineering News of Nov. 9, 1899, there appeared a small sketch and a brief description of a "Centrifugal" railway proposed to be erected at some amusement resort, to replace in the favor of a pleasure-loving public the old-time roller coaster. The accompanying drawings and photographs show a similar "Centrifugal" railway built by the Boston Bridge Works during the past summer, which may be of interest to engineers and others as a novelty.

A brief description is as follows: The railway was built during June, 1900, at Revere Beach, by the Revere Beach Roller Coaster Co., under patents granted to Mr. Edwin Prescott, of Arlington, Mass. The structure is of wood with the exception of the "loop," which is made of steel, the latter being the design of Mr. J. R. Worcester, M. Am. Soc. C. E., Consulting Engineer, Boston, Mass.

The general arrangement is as illustrated in the accompanying drawings; the cars are hauled up an incline to a tower 42 ft. high, and are swung around on a turntable into position for the descent. The descending slope is on an angle of 30° with the horizontal, and at its bottom occurs the upright loop which has a diameter of 29 ft., and around which the cars go at terrific speed. After leaving the loop the cars continue around a circuitous path for a quarter of a mile. The journey

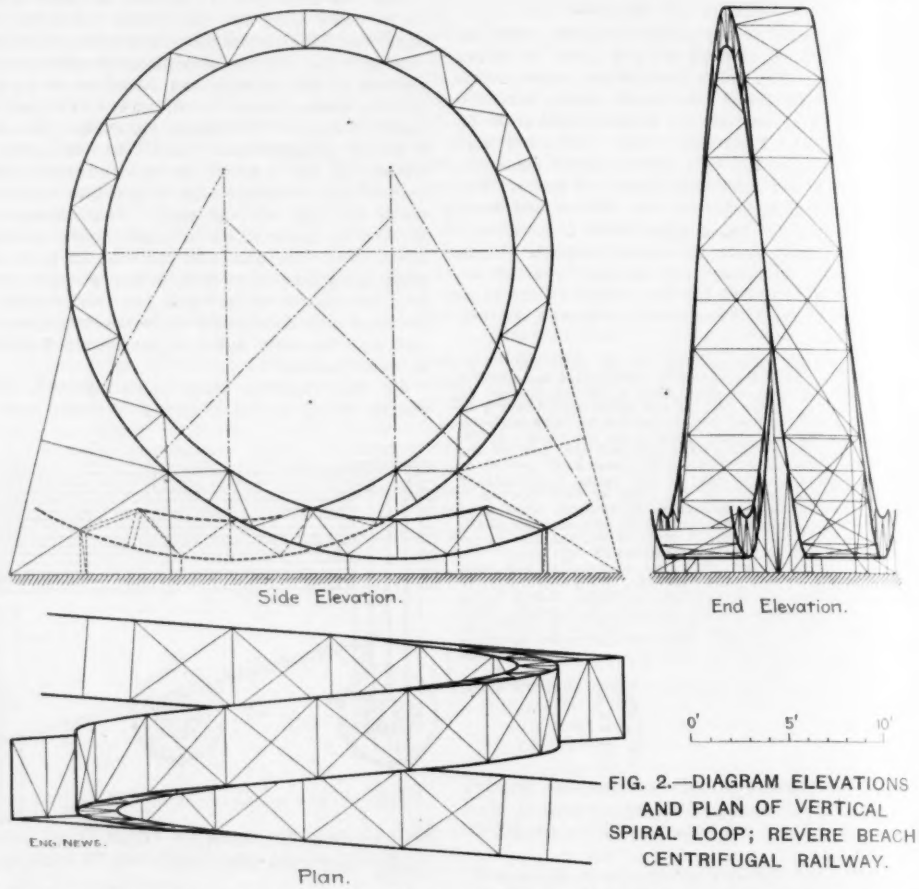


FIG. 2.—DIAGRAM ELEVATIONS AND PLAN OF VERTICAL SPIRAL LOOP; REVERE BEACH CENTRIFUGAL RAILWAY.

lasts about two minutes from the time of entering the car and is said to be exciting and exhilarating, though the writer has never mustered up sufficient courage to attempt it and so cannot speak authoritatively on that point.

The cars have small wheels over the track wheels for the purpose of fitting inside the inner chord angle of the loop and prevent the car from falling out should any obstruction, by any possibility, stop it. The trucks are also swiveled by an ingenious arrangement so that the wheels are always square to the rails. Safety appliances guard the excursionist from accident should the hoisting rope break or the car jump the track on any of the sharp curves of the coaster proper.

In view of the doubts expressed in the article of Nov. 9, as to the patronage the public would grant such a device, the following facts concerning the coaster at Revere Beach may not be out of place: During the time the railway has been running, from July 4 to present time, there have been sold on an average some 4,000 tickets per day at 5 cts. each, the greatest number on any one day being 11,800. These figures we think will prove that what at first appearance may have seemed an impracticable scheme has turned out to be a remarkably good investment.

From the drawings and photographs sent us by Mr. Brown we have selected those reproduced in Figs. 1, 2 and 3. Fig. 1 shows a general view of the loop and a portion of the connecting tracks, the routes of which can be traced fairly well upon close examination. Fig. 2 shows diagram elevations and a plan of the loop portion of the line, and it will be noticed that some rather curious designing was called for in its construction. Fig. 3 shows the general composition and dimensions of the loop framing. According to Mr. Brown's figures, the difference in height be-

*Engineering News, Oct. 25, 1900.
†Chief Engineer, Boston Bridge Works, Boston, Mass.

tween the top of the tower and the top of the loop is about 13 ft. Assuming that friction and air resistance will consume the energy stored up by the car falling 3 ft., we then have a clear fall of 10 ft. to give it velocity at the top of the loop. Using the familiar formula $V = \sqrt{2gh}$, in which h is 10 ft., we have $V = \sqrt{64.4 \times 10} = 25.37$ ft. per second, or about 17 miles per hour, as the speed at which the car is traveling when it passes the top point of the loop. The "proof of the pudding is the eating," and the fact that 4,000 people a day are riding around this loop in safety seems to disarm criticism. Like Mr. Brown, however, we fear that we should be unable to muster up courage to take the ride, "exciting and exhilarating" as it is reported to be.

Since writing the above we have received the following letter, also prompted by our article of Nov. 9, 1899:

SIR: In your issue of Nov. 9, 1899, you took the trouble to ridicule a centrifugal railway which we built and successfully operated last season. We have another road at Coney Island at the "Chutes," where last Saturday and Sunday as many as 500 persons were continuously in line waiting for the opportunity to ride and paying for the amusement. It will be unfortunate for you to have these roads running right under your nose and being ridden on daily by many of your subscribers who have heretofore valued your engineering ability. Next season will be even more interesting. Yours truly,

Osborn Congelton, President American Railway Co.
6 Wall St., New York, Sept. 13, 1900.

Concerning this communication we may remark that a careful study of our original article will show that we specifically stated that there was no doubt that a railway of this construction could be built which would work. The doubt we did express was as to whether people would patronize for amusement a railway which "put their heads where their heels ought to be." According to the statistics submitted above, our knowledge of human nature was defective, and we stand corrected.

We may note again here that the invention is really an old one revived. In our issue of Dec. 14, 1899, a San Francisco correspondent described one of these centrifugal railways which was in operation at a pleasure resort near Liverpool, England, in 1859, having a loop about 16 ft. in diameter. An inventor in Montreal, Canada, also devised a similar railway about the same time, apparently with no knowledge of what had been done in England. A member of the staff of this journal remembers seeing a small-size working model exhibited by this inventor in Montreal at the Provincial Exhibition in the fall of 1860. So far as we know, however, the Liverpool structure was the only one actually built and operated until the recent revival of the invention in the United States.

REPORT OF THE INTERNATIONAL TRAMWAY (STREET RAILWAY) CONGRESS AT PARIS.

The international tramway congress, organized under the direction of the International Tramway Union, was held at Paris in September, and from the official report of the proceedings we abstract the following particulars. The first meeting was held Sept. 10, the chair being taken by Mr. Perouse, Government Director of Railways, who represented the Minister of Public Works. His opening address was replied to by Mr. Janssen (of Brussels), President of the Committee on Organization, and by other speakers.

A report on "Street Railway Fares" was presented by Mr. Geron, in which special reference was made to the present tendency towards low fares, uniform fares, and free transfers. His conclusions were as follows: (1) In towns, the fares should be low and simple, established in conformity with local requirements; (2) In large cities there should be an interior zone, as large as possible, in which there should be a uniform fare, but not including suburban lines; (3) A transfer system is desirable, but whether this is free or involves a supplementary fare, depends on local conditions. No general conclusions can be formulated, as local conditions have an important bearing on each individual case. Several members expressed decided objection to transfers, on the ground of reduction in average receipts per passenger and the difficulty of controlling the use of transfers. A reduction of rates was considered preferable, and in the report as adopted the third recommendation noted above was struck out.

A report on "The Result of Introducing Electric Traction on Existing Lines," was then presented by Mr. De Pirch (of Elberfeld), the conclusion of which was as follows:

Experience has shown that electric traction with overhead wires is advisable for replacing traction by animals, and even traction by steam locomotives, where small trains make long runs at short intervals with heavy traffic, as well as for lines with heavy grades; provided, that the concession or franchise is of sufficient duration, and that unreasonable requirements or high fares do not prevent the economical operation of the line.

Mr. Monmerque (of Paris) agreed with the conclusions, but pointed out that the question related to electric traction in general, while the author had referred exclusively to the overhead system, but the conclusions were allowed to stand without change.

At the second meeting, Mr. Lavalard (of Paris) in the chair, a report by Mr. Gunderloch was read by Mr. Oudenijk on "The Advantages and Disadvantages of Narrow Gage and Standard Gage Track for Electric Railways, Particularly in Regard to the Adoption of Motors and Machinery of Sufficient Power." The report advocated the standard gage, and presented no disadvantages for that gage, except on lines built on an independent right of way, where a narrow gage would require less land and earthworks. He questioned, however, whether these disadvantages were of importance. The conclusions presented were as follows:

The standard gage presents numerous advantages for electric traction, and is more generally applicable. The opinion often expressed that all secondary or local railways should have a gage of 1 meter, in order to allow of the interchange of rolling stock, cannot be sustained, as this matter is of less importance than interchange with the main lines. The narrow gage should only be adopted when there are very strong reasons for its preference.

Mr. de Burlet (of Brussels) agreed with the report as far as it related to city and passenger lines, but not in regard to local lines extending from the towns into the country districts, where expense is the prime consideration. He mentioned the Belgian National Local Railways Co., which has about a hundred lines aggregating 1,550 miles, of which only three lines are built to standard gage. It was further pointed out that at the congress of 1895, the conclusion was arrived at that the narrow gage should be adopted for steam tramways, except for short lines with important freight traffic connecting with main lines. Similar ground was taken by Mr. Haselman (of Aix-la-Chapelle) and Mr. Trautweiler (of Strasburg), as in Europe a narrow gage is very generally adopted for local or secondary lines. In view of the absence of the author, the matter was laid aside, to be considered again at the next congress.

A report on "Central Station Equipment for Electric Railways," was presented by Mr. Thonet and Mr. d'Hoop. The conclusions were as follows: (1) In large plants, it is necessary to adopt compound condensing engines, directly connected to the dynamos; (2) In plants of moderate size, there is generally a good opportunity to use storage batteries as auxiliaries; (3) In small plants, if coal is expensive, gas or gasoline engines may be used to advantage. A proposed amendment, to the effect that storage batteries were advantageous in all cases, was opposed by Mr. Thonet, who considered that there was not yet sufficient experience to warrant recommending them for large plants, where the number of cars is sufficient to work the plant at its normal capacity and where the batteries would involve heavy additional capital expenditure. An amendment was accepted, however, to the effect that either compound or triple-expansion engines should be adopted for large plants.

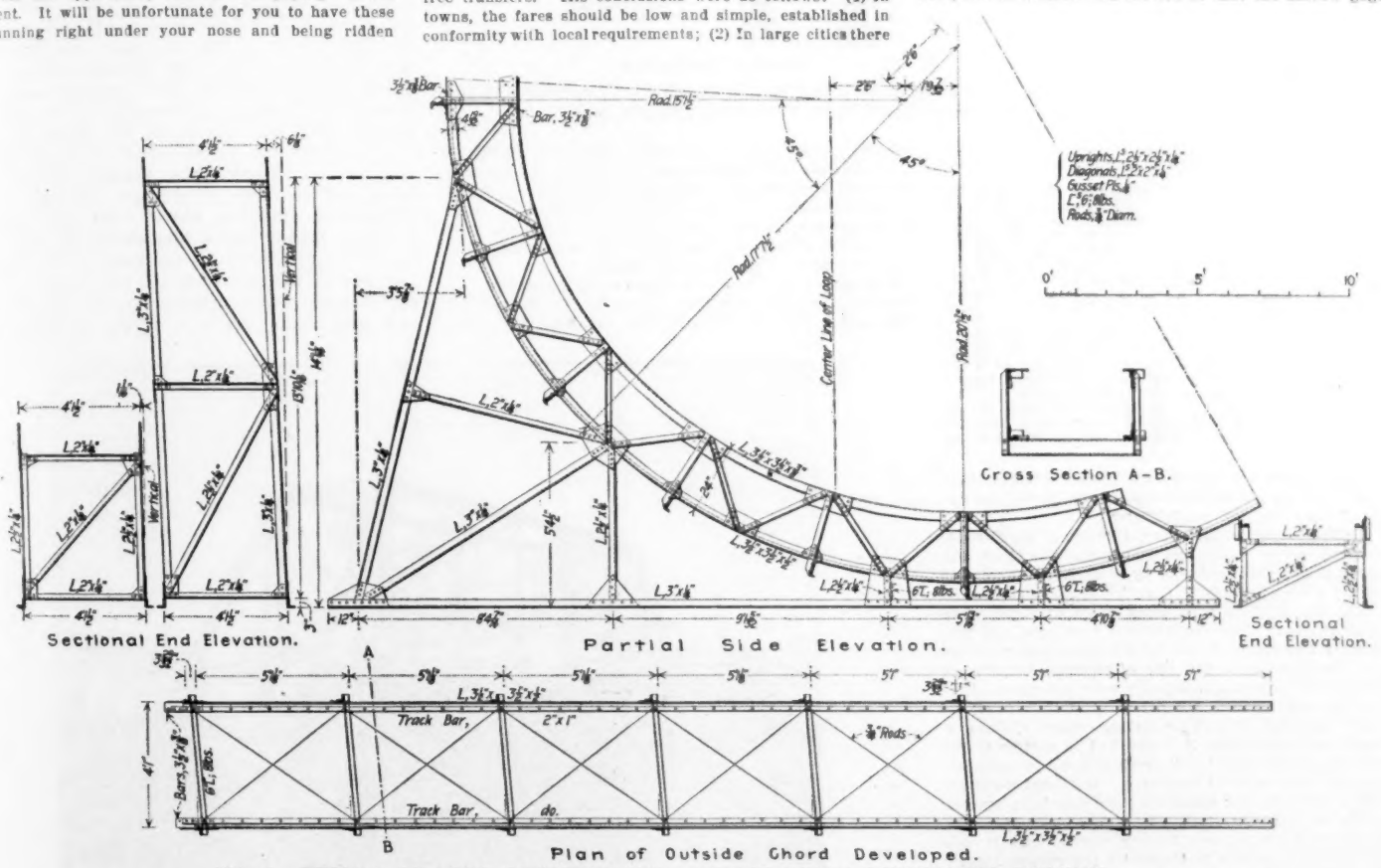


FIG. 3.—DETAILS OF LOOP CONSTRUCTION; REVERE BEACH CENTRIFUGAL RAILWAY.

The next report was one by Mr. Van Vloten on the following subject: "What is the Best System of Distribution for Large Tramway Systems with Suburban Lines Capable of Long Extensions: Continuous, Alternating or Polyphase Currents?" This was read by Mr. Pedriali, Chief Engineer of the Brussels Tramways Co., and presented the following conclusions:

(1) When the line does not extend more than 5 or 6 miles from the power station, and the traffic is not too heavy, preference may in general be given to the ordinary direct distribution by continuous current, with or without storage batteries.

(2) When the line extends 10 miles from the station, the use of the alternating current with step-up and step-down transformers and storage batteries is of advantage.

(3) In special cases, storage battery cars may be preferable for lines not exceeding 10 or 12 miles in length.

(4) The continuous current series system may be applied on lines of greater length, especially when a distant water power can thus be utilized, but this has the general objection to all series systems, and is not advisable when the traffic is very variable.

(5) Distribution by polyphase currents, with substations having direct current transformers feeding the trolley lines, presents advantages in regard to the use of water power, and especially for lines of 12 to 18 miles in length, with heavy trains and heavy, but variable traffic.

(6) Direct distribution by polyphase currents to the motors on the cars is only adapted for railways operated on an independent right of way, and not for street tramways.

The next report was read by Mr. Fischer-Dick (of Berlin) on "The Falk Cast-Welded Joint for Rails," an abstract of which we shall publish later.

At the third meeting, Mr. Levy, Director of the Paris & Seine Department Tramways Co., occupied the chair, and the first report presented was by Messrs. Johannet and Broca on "Storage Battery Cars." The report showed that this system offers advantages where overhead wires are prohibited, or where the traffic is very light, and that it involves less capital in no special construction of the track. Possibilities in the way of securing batteries of lighter weight with greater capacity were suggested. Reference was also made to the flexibility of this system as compared with the conduit or surface-contact systems in cases of emergency when it is required to operate traffic on only one track of a double-track line, or to make deviations in order to avoid blockades. Overhead wires are forbidden in Paris, and storage-battery cars have been in operation in that city since 1892. The discussion was unfavorable to the storage battery system, and it was stated that little success had attended the various experiments, while the necessity of providing enormous battery capacity to provide for emergencies, and the resistance due to snow or greasy rails, would make the cost much higher than when an average battery capacity is assumed. Mr. Micke stated that in Berlin, where the trolley and battery systems are both in use (the latter on about 12 miles of line), the operation of the latter was entirely stopped last winter by heavy snowfalls, and the authorities have ordered it to be replaced. This will be done by the extension of the trolley system and the use of the conduit system where overhead wires are not permitted. The batteries were charged from the trolley lines while the cars were running over that section, and were often only partly charged when they reached the end of the trolley line. If it is absolutely necessary to employ storage-battery cars they should be charged at the power station. Mr. Kruger said that at Hanover very satisfactory results have been obtained with storage-battery cars, which are charged while running on long sections operated by the trolley system, so that the batteries are fully charged when the cars reach the end of the overhead wires. Mr. Janssen, replying to the objections made, stated that as some lines had been very successful, it is possible that unsuccessful lines have not been operated properly. He also pointed out that the report recommended it for use only where overhead wires are forbidden. The meeting, however, adopted a resolution to the effect that from the point of view of public utility, and disregarding the high cost of operation, the storage-battery system cannot ensure the necessary regularity and elasticity of service for heavy traffic, as in times of crowds. It is less reliable and more troublesome than the trolley system, and should only be used under very exceptional conditions.

At the fourth meeting, Mr. Leon Janssen in the chair, the first report was on "Car Heating on Local Lines, for Passenger and Mixed Trains," by Mr. Burlet. This stated that little progress has been made since 1894. Mr. Monmerque stated that the Paris public regulations required the heating of all street cars and omnibuses, for which purpose stoves burning briquettes made from coal dust are used. It was decided to refer the subject of heating the cars of street and local railways for another report. Mr. Ziffer then presented a report on "The Operation of Secondary Railways by Independent Companies, and by the Main Lines of Which They are Feeders." He thought that no general conclusion could be presented, as the conditions vary in all cases. Mr. Scotter (of London) advocated operation by independent companies. A report by Mr. Macloskie, on "The Adoption of a Uniform Basis for Measuring the Power of Dynamos and Motors," was read by Mr. d'Hoop, but the matter was laid over for further consideration by the next congress.

A discussion on "Brakes for Tramways Operated by Mechanical Traction," was then opened by Mr. Monmerque, who stated that the Paris General Omnibus Co., which operates the tramways, is trying five systems of brakes, three of which are operated by driver or motorman, and two are automatic. Mr. Von Leber said that in Austria the cars usually have two brakes, a chain brake operated Electric track brakes were also referred to. This closed the technical part of the proceedings.

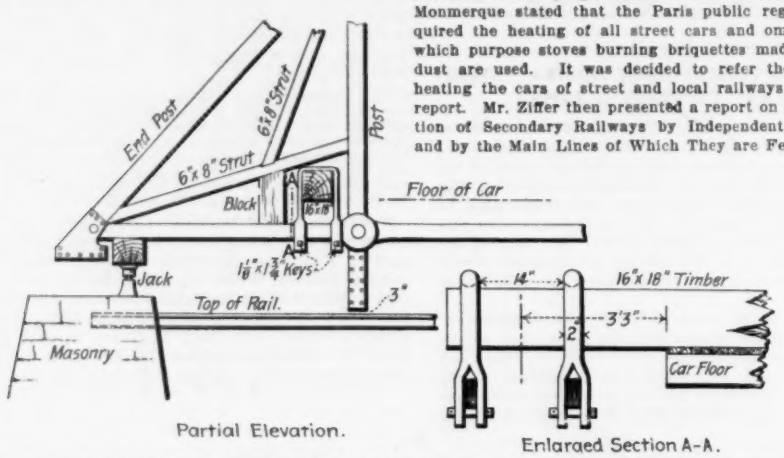


FIG. 1.—SKETCH SHOWING METHOD OF LOADING AND SUPPORTING 125-FT. THROUGH TRUSS BRIDGE SPAN ON CARS FOR TRANSPORTATION; HOCKING VALLEY R. R.

TRANSPORTING THREE 125-FT. THROUGH BRIDGE SPANS, HOCKING VALLEY RY.

The transportation of heavy plate girders and single bridge trusses by rail has become so common a matter in the United States that only a particularly unusual feat of this character attracts attention. It is quite unusual, however, we believe, to pick up bodily a complete bridge span and convey it some thousands of feet by rail to a new substructure, and to form a new crossing. This task has recently been accomplished with great success by the Maintenance of Way Department of the Hocking Valley Ry., and through the courtesy of Mr. William Michel, Engineer Maintenance of Way, we are able to present a brief description of the methods employed.

The bridge which was moved consisted of three through truss pin-connected spans, each 125 ft. long and 24 ft. high, and each weighing 42 tons. The object of moving this bridge, which was located near Spring St., in Columbus, O., was to make room for the construction of a new double-track bridge, and at the same time to secure a double-track crossing at Mound St., 4,800 ft. away, by placing the old Spring St. single-track bridge alongside the Mound St. single-track bridge already built. The interesting feature of the work consisted, of course, in the methods adopted for loading the three 125-ft. spans, and for transporting them to their new location, and these are shown by the accompanying engravings, Figs. 1 and 2.

The first work was to cut loose the floor beams of the three spans and support the detached floor system on a trestle built underneath. The trusses were then braced by timbers, as shown by Figs. 1 and 2. The next step was to jack up the trusses and their bracing until the bottoms of the floor beam hangers cleared the rail about 3 ins. The method of jacking up the spans is indicated by Fig. 1, and the total height which they were raised was about 4 ft. After each span was jacked up three flat cars, with their springs removed and blocks placed under the truck bolsters, were run between the trusses. Timbers 16 × 18 ins. in cross section were laid across the car floors at two points, where the first vertical end posts of the span came, and from these timbers stirrups were hung and arranged to support the lower chord eye-bars, as shown by Fig. 1. The block and the 6 × 8-in. timber struts, also shown in this drawing, were introduced for the purpose of transferring part of the load from the lower chords to the upper chords of the trusses. As soon as the stirrups and struts had been placed the jacks were lowered and the weight of the span transferred to the cars. The next step was to haul the loaded span to its new site and lower it into position.

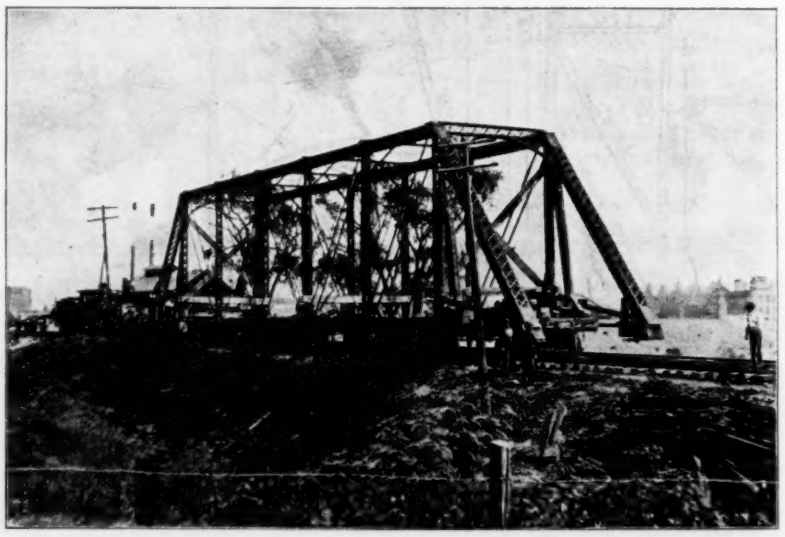


FIG. 2.—VIEW OF 125-FT. SPAN BRIDGE BEING TRANSPORTED TO A NEW SITE; HOCKING VALLEY RY.

Fig. 2 is a view from a photograph showing one span on its way to its new location. The distance which each span had to be carried, as already stated, was 4,800 ft., and in this distance the cars had to pass around four 6° curves and through two switches with No. 8 frogs. When the new site was reached the spans were run out on a temporary trestle built between the masonry; raised clear of the cars by jacks, as shown by Fig. 1, and then lowered onto the masonry after the cars were withdrawn. The run between the old and new sites for the span occupied about 50 mins., and the total time consumed in raising, loading, transporting and lowering each span to its new position occupied about three hours. The final task was to replace the floor system ready for traffic.

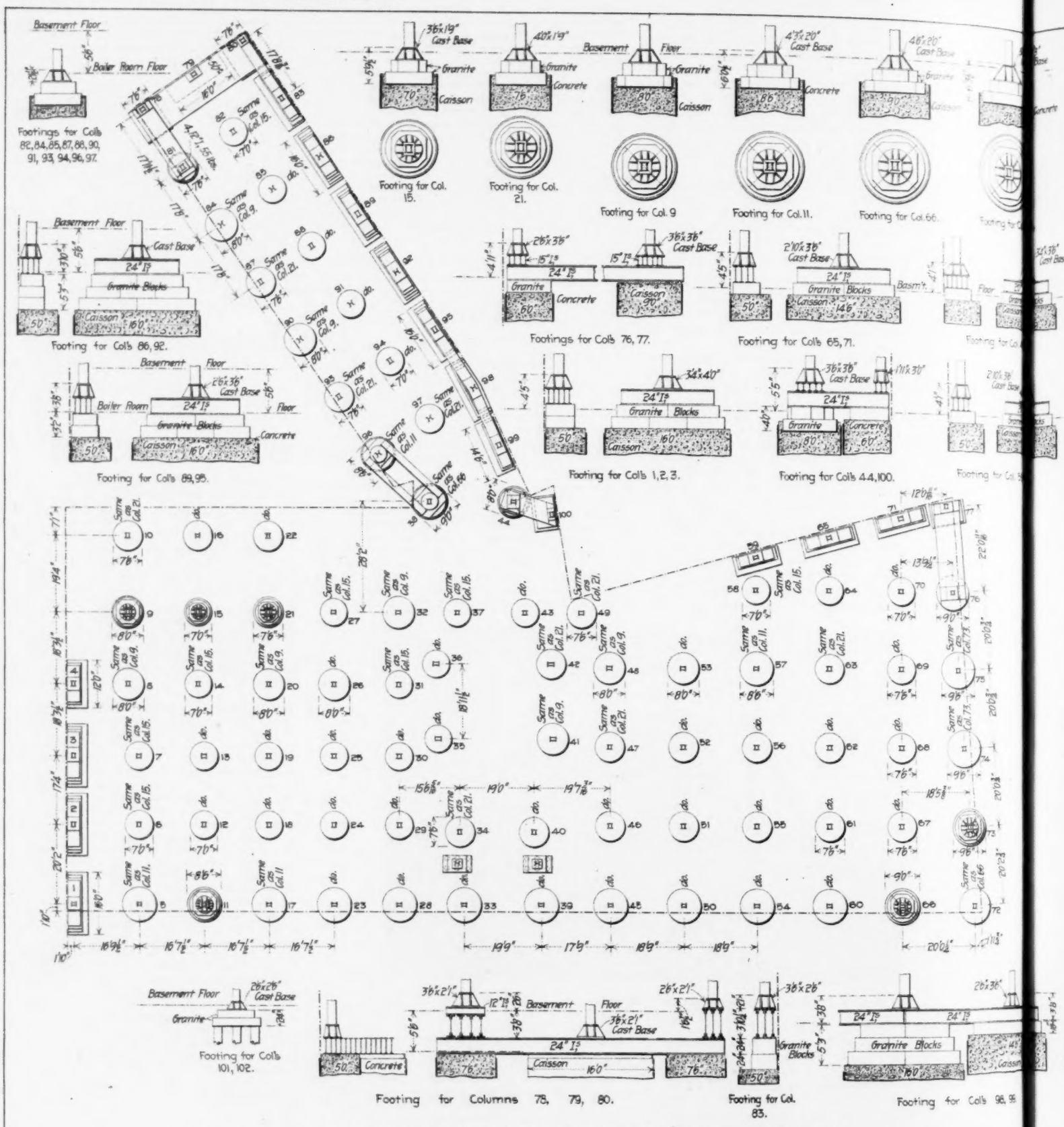

Footings for Cols 82, 84, 85, 87, 88, 90, 91, 93, 94, 96, 97.
Footing for Cols 86, 92.
Footing for Cols 89, 95.
Footing for Col. 15.
Footing for Col. 21.
Footing for Col. 9
Footing for Col. 11.
Footing for Col. 66.
Footings for Cols 76, 77.
Footing for Cols 65, 71.
Footing for Cols 1, 2, 3.
Footing for Cols 44, 100.
Footing for Cols 101, 102.
Footing for Columns 78, 79, 80.
Footing for Col. 83.
Footing for Cols 98, 99.

FIG. 2. GENERAL PLAN AND SECTIONAL ELEVATIONS OF CAISSON FOUNDATIONS.

PNEUMATIC CAISSON FOUNDATIONS, BRO[illegible] EXCHAN[illegible]

Clinton & Russell, New York City, Architects. Purdy & Henderson, Ne[illegible]York City, [illegible]

Engineering Contract Co., New York C[illegible] Sub-Cont[illegible]

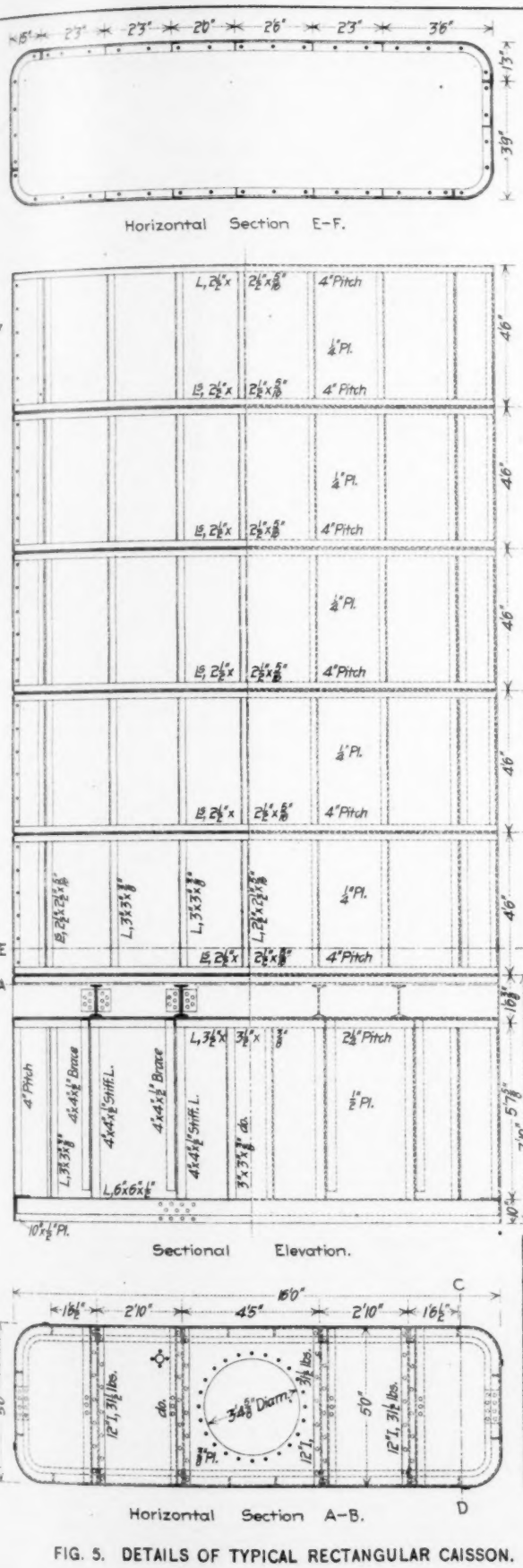


FIG. 5. DETAILS OF TYPICAL RECTANGULAR CAISSON.

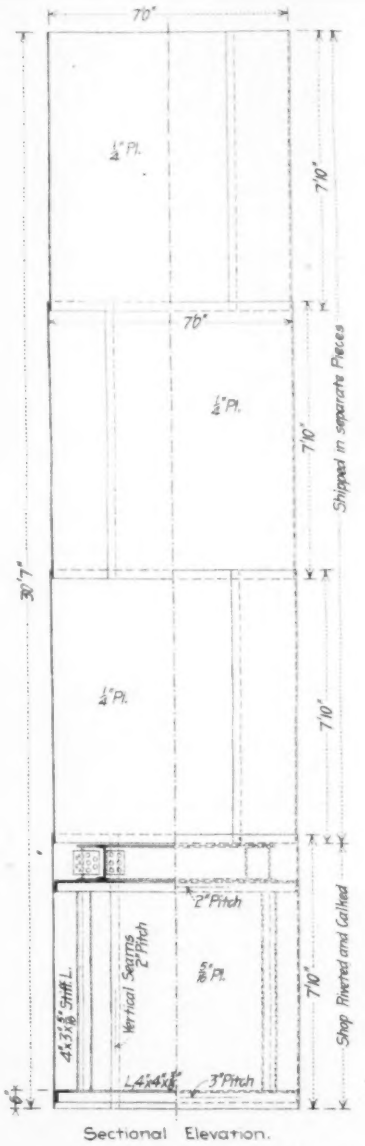


FIG. 4.
DETAILS OF
7-FT.
CYLINDRICAL CAISSON.

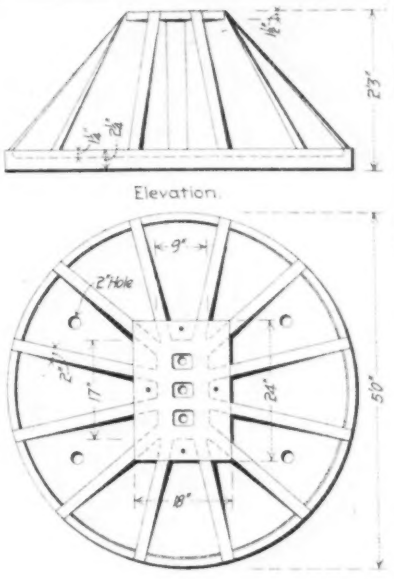


FIG. 6. DETAILS OF
CIRCULAR COLUMN PEDESTAL.

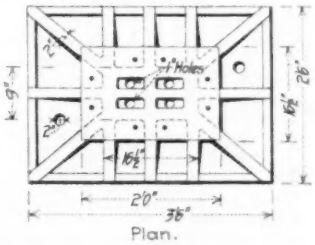


FIG. 7. DETAILS OF
RECTANGULAR COLUMN PEDESTAL.

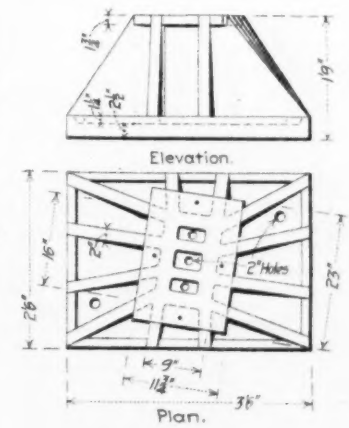


FIG. 8. SPECIAL PEDESTAL
FOR COLUMN No. 77.

EXCHANGE BUILDING, NEW YORK CITY.

York City, Engineers. Geo. A. Fuller Co., New York City, Contractors.

Sub-Contractors for Pneumatic Work.

CHAS. HART, LITH., 88 VESEY ST., N. Y.